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ELECTRONICS

4 STC 16 STC 20 23 26 40 SILICONE CONTAMINATION BRIDGE 44 CURRENT VOLTAGE 47 STC 48 FILTER 50 62 CUSTOM FRONT PANEL
10 SOUND SWITCH BACK PANEL SYSTEM

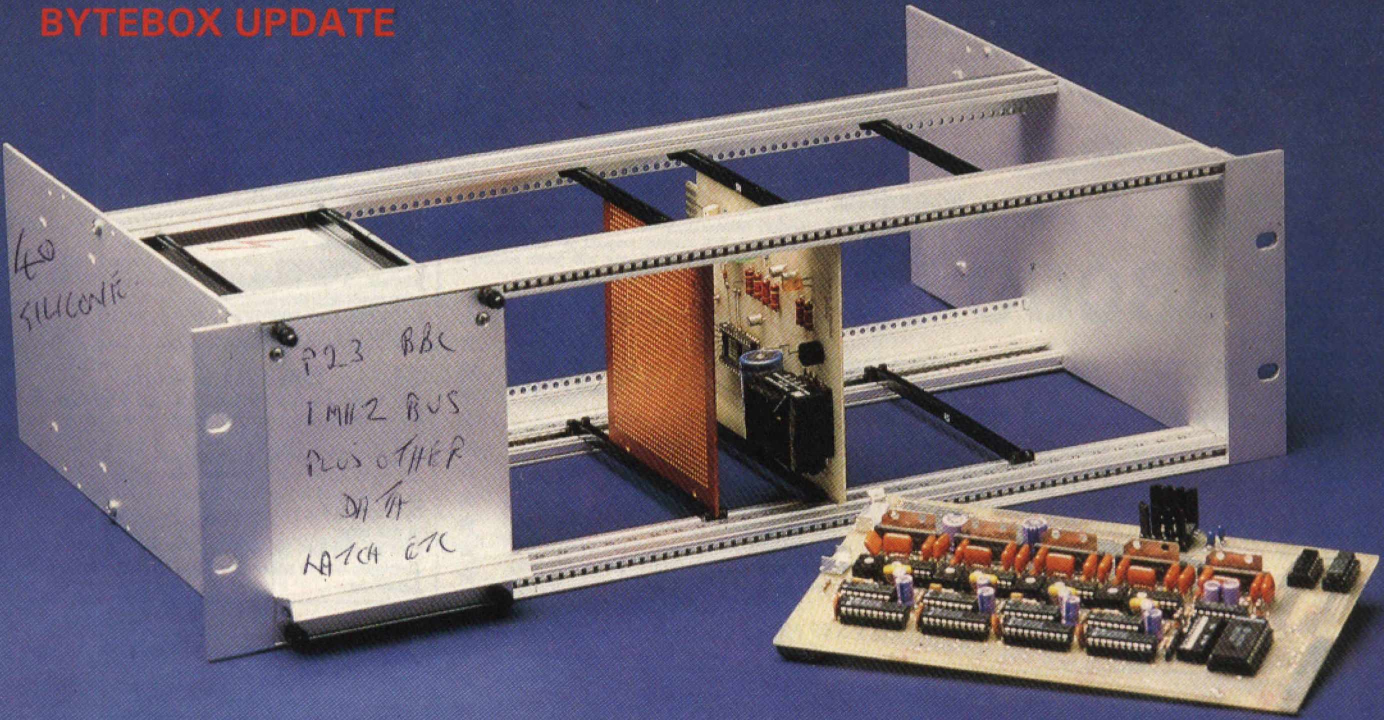
ROBOTICS · MICROS · ELECTRONICS · INTERFACING

SETTING THE STANDARD

PHOTOGRAPHIC TRIGGER UNIT

NOISE REDUCTION SYSTEM

BYTEBOX UPDATE



IEEE P1000 STANDARD

PE HOBBY BUS STANDARD

THE MAGAZINE WITH PROJECTS FOR ALL HOME MICROS

PE ROBOTICS MICROS ELECTRONICS INTERFACING

VOLUME 22 No. 4
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OUR MAY 1986 ISSUE WILL BE ON SALE FRIDAY, APRIL 4th, 1986 ***(see page 37)***

WHAT'S NEW...

Surfboards Aid Surface-mount Prototyping

Global Specialties has introduced a completely new concept for building prototype circuits using surface-mount chips.

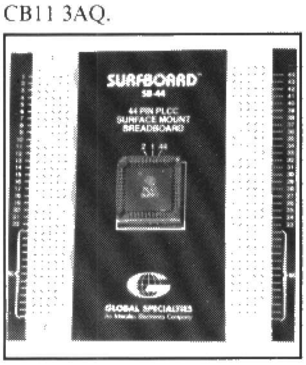
With Global's Surfboard the designer places a plastic leaded chip carrier (PLCC) into a chip carrier socket and has instant breadboarding access to the electronics in the chip, without soldering or permanent connections.

The Surfboard provides a numbered breadboarding tie-point for each lead on a chip carrier. Connection of a particular lead is achieved by inserting standard 22-gauge hook-up wire into the corresponding tie-point.

The Surfboard chip carrier socket is fabricated in phosphor bronze with tin-plated contacts. It accepts a JEDEC type A PLCC and is polarised for easy registration. Stand-offs are provided for heat dissipation.

The breadboard has replaceable nickel silver contacts and accepts components which have up to 0·033 in. leads. Three Surfboard models are available which accommodate 44, 68 and 84-pin PLCCs.

Details from: Global Specialties Corporation (UK) Ltd, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.



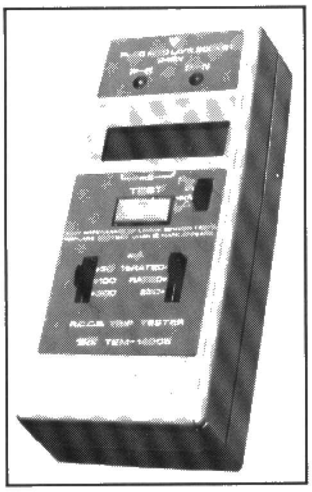
Intelligent Digital Multimeter

The new intelligent multimeter from M.S. Components features a wide range of computing and automatic data storage functions.

Microprocessor-controlled, it displays both direct readings and computed functions on a clear $5\frac{1}{2}$-digit l.e.d. display with a resolution of $\pm 1\mu V$ or 1nA. A total of 28 ranges are available.

Computed functions are keyed in via a built-in keypad and include ground reference shift, percentage deviation, limit comparison and many other functions. An integral logging memory, with programmable timing, has a capacity of 100 readings and an optional RS232 serial interface is available for data output.

Details from: M.S. Components Ltd, Zephyr House, Waring Street, West Norwood, London SE27 9LH.



Digital R.C.C.B. Trip Tester

TMK announce the availability of model TEM 1400B, a new digital R.C.C.B. Trip Tester complying with the 15th Edition of the IEE Wiring Regulations. TEM 1400B is designed to make quick, safe and accurate measurements of the trip time of residual current circuit breakers at various required levels of fault current, a test that has become increasingly important.

This new $3\frac{1}{2}$ digit l.c.d. instrument is easy to operate, hand held and battery operated, with bright l.e.d. indication of P–E and P–N. Trip times are measured from 0 to 200ms with a 1ms resolution to a $\pm$5msec accuracy and trip times can be held for up to 40s until the push button is released.

The TMK, TEM 1400B is compact, rugged, reliable and is fully guaranteed, measures 142 × 62 × 34mm, weighs approx. 250gms and comes complete with a mains test lead, battery, operating instructions and carrying case.

Details from: Harris Electronics (London), 138 Grays Inn Road, London WC1X 8AX.

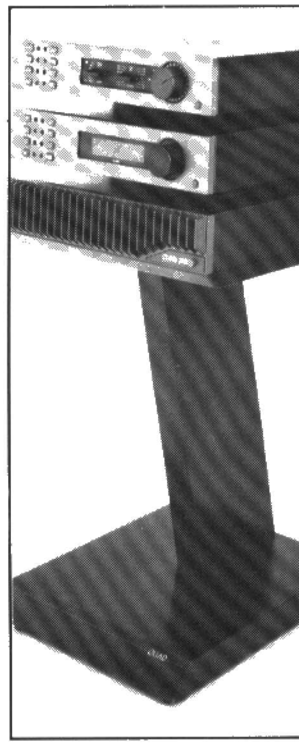
Quad 306 Power Amplifier

QUAD, in the guise of the Acoustical Manufacturing Company, was founded in 1936. It is fitting that their first news in their 50th anniversary year, is the announcement of a new power amplifier.

The QUAD 306 is designed to provide the most accurate and realistic music production in high quality domestic systems. Power output is more than adequate for the vast majority of systems (70 watts into 8 ohms on music programme).

The QUAD 306 uses a refined and developed version of the feed forward error correction circuit which QUAD patented in 1975 and nicknamed "Current Dumping". Some of the more obvious features of the QUAD 306 are separate power supplies for each channel, derived from separate secondary windings on a common toroidal transformer, and absence of fuses or relays in the signal path, and a signal-to-noise ratio of 110dB. It is fully protected against damage, accidental or otherwise.

Details from: QUAD Electroacoustics Ltd, Huntingdon, Cambs PE18 7DB.



50MHz Oscilloscope With Digital Display

Electronic Brokers has recently introduced the Grundig MO-53 50MHz dual-channel oscilloscope to the UK market. The new oscilloscope includes many features designed to make it easy to use in areas such as R & D, production, service and education.

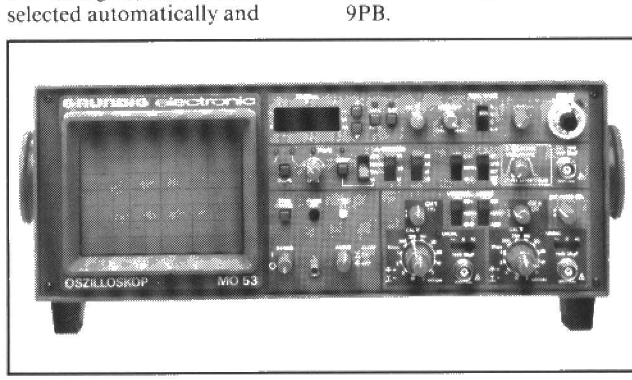
A major new feature included in the MO-53 is automatic timebase selection. Depending on the frequency of the test signal, the timebase is selected automatically and displayed digitally, so that the user has no need to search to find the correct range.

For video testing applications, the MO-53 has a field and line selector, allowing the defined selection of the field 1 or field 2 to take place automatically. Triggering occurs approximately ten lines ahead of field re-start.

Other features of the MO-53 include the full –3dB bandwidth of 50MHz being maintained at the smallest deflection factor of 2mV/cm, and the facility for inverting both Y-channels to ensure true displays of X/Y characteristic curves.

Full service and support for the Grundig instrument range is provided in the UK by Electronic Brokers.

Details from: Electronic Brokers Limited, 140–146 Camden Street, London NW1 9PB.



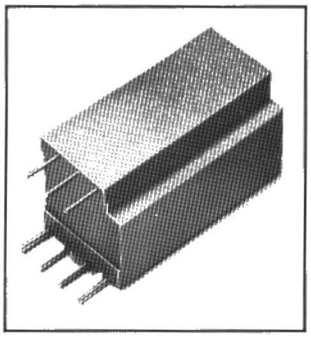
WHAT'S TO COME...

Programmable plug from Aries Electronics

A new 7 pin programmable plug is now available from Aries Electronics. Capable of being programmed up to thousands of variations, the device features an extra long handle for ease of insertion when working with densely populated p.c. boards.

The plug allows the development of individual programs which can be indentified by simply numbering the outer shell. To give even greater variation in programming any number of pins can be accommodated while polarising pins on any spacing or other variables are possible.

Details from: Aries Electronics (Europe), Alfred House, 127 Oatlands Drive, Weybridge, Surrey KT13 9LB.



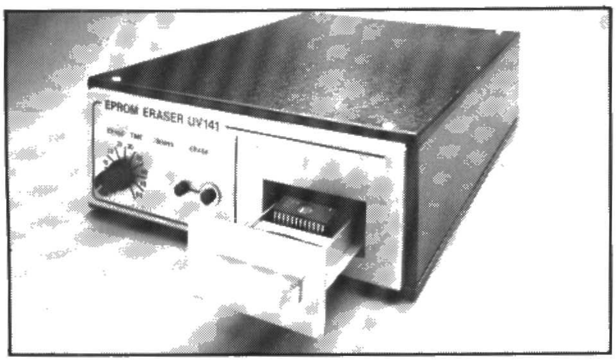
EPROM Eraser from GP Industrial Electronics

An EPROM eraser—which is capable of erasing up to 14 EPROMs simultaneously by exposing them to short-wave, ultra-violet radiation – is now available from GP Industrial Electronics.

Called the MODEL 141 EPROM ERASER, the device incorporates an electronic timer adjustable from 5 to 50 minutes in discrete steps. This provides a very useful "set and forget" facility which prevents accidental over-exposure which can shorten an EPROM life.

The 141 also features an easy-to-use slide-in tray for the loading of EPROMs, and panel indication to show when the device is in use. It is available for around £88.

Details from: GP Industrial Electronics, Unit E, Huxley Close, Newham Industrial Estate, Plymouth.



Home-Base CB Power Supply from a Kit

CB radio enthusiasts can power their mobile radio units from the mains with a new high quality power supply kit from Electronic and Computer Workshop Ltd. (ECW).

The kit, the K2556, is designed primarily for home-based applications, providing a regulated d.c. output—nominally 12 volts—but adjustable from 11 to 13·5 volts d.c. Maximum current rating is 3·5 amps.

All the necessary items are supplied with the kit, including a high quality p.c.b., all electronic and mechanical components. Instructions are included to make assembly and testing very simple.

Full overload protection is included with an overload l.e.d. Although designed for CB applications, the performance of the K2556 makes it suitable for a wide range of amateur radio and laboratory applications.

ECW can supply the kit at a price of £30.87 including p&p and VAT.

Details from: Electronic and Computer Workshop Ltd, 171 Broomfield Road, Chelmsford, Essex CM1 1RY.

POINTS ARISING...

There are no points arising from articles published in the March issue of Practical Electronics, but we have a Bytebox Update on page 26. Bytebox was published in Practical Electronics, October and November, 1985.

COUNTDOWN

Events, diary dates and forthcoming attractions

Practical Electronics gives you the dates that matter. We hope to expand the countdown page to bring news of more regional events as we appreciate that many readers have difficulties getting to the larger shows based mainly in London or Birmingham.

If you are organising any electrical, computing, electronic, radio or scientific event, big or small, drop us a line. We shall be glad to include it here. Address details to Countdown, Practical Electronics, 16 Garway Road, London W2 4NH.

NOTE: some exhibitions detailed here are trade only. Please check details and dates before setting out, as we cannot guarantee the accuracy of the information presented here.

Amstrad Computer Show May 31–June 1. Novotel, Hammersmith. **K**
Atari Computer Show Mar. 7–9. Novotel, Hammersmith. **K**
Electro-Optics/ Laser International Mar. 18–20. Metropole, Brighton. **B.**
Robotics and Automated Systems Mar. 25/26. Imperial College. **L.**
CAD '86 Apr. 8–10. Metropole, Brighton. **J**
Internepcon Production Show Apr. 8–10. NEC, Birmingham. **B**
British Electronics Week Apr. 29–May 1, Olympia. **M**
East Suffolk Wireless Revival May 25. Civil Service Sportsground, Ipswich. **C**
SCOTELEX '86 June 3–5, Royal Highland Showground, Edinburgh. **D**
Software '86/Business Computer '86 June 3–5. Earls Court. **E**
Amateur Electronics Exhibition July 12–20. Esplanade, Penarth. **A**

A B.A.E.C. ☎ 0222 707813
B Cahners ☎ 01-891 5051
C Ipswich Radio Club ☎ 0473 44047
D Institution of Electronics ☎ 0706 43661
E Reed Exhibitions ☎ 01-643 8040
F ASCE Ltd. ☎ 06268 67633
G Electrex Ltd. ☎ 0483 222888
H Online ☎ 01-868 4466
I Trident Int. Ex. Ltd. ☎ 0822 4671
J Butterworth Scientific Ltd. ☎ 0483 31261
K Database ☎ 061-456 8383
L Imperial College ☎ 01-589 5111
M Evan Steadman ☎ 0799 26699

WHAT'S HAPPENING . . .

RECOGNITION AT LAST

A RECENT report in the *Sunday Times* suggests that engineers and technologists will, at last, be recognised as important contributors to the management of major organisations. In the past, managers have come, primarily, from financial backgrounds and more recently from marketing, However, especially in America, in the 1990's the information technology specialists will have become the dominant group among the executives running major organisations.

Also, companies will be looking for the entrepreneurial spirit and the ability of its employees to diversify.

COMPUTER ALIEN REPELLENT

GRiD Compass portable computers, already used by NASA on board numerous space shuttle missions are to be used to ward off alien invaders in outer space.

The computers are not the latest piece of hardware to be deployed in the current US Star Wars technology, but are to play a part in "ALIENS", the follow up to Twentieth Century Fox's classic 1979 work of science fiction, "ALIEN".

Twentieth Century Fox set designers got in touch with GRiD Systems in Reigate after they had read about the GRiD portable being used in the NASA space shuttle programme.

On the subject of space, the next Amateur Radio satellite in the Phase-3 series is nearing completion as teams in Marburg, West Germany and the United States close in on important milestones leading to an anticipated August, 1986 launch. Plans call for a launch aboard an Ariane 4 this August, however, a set-back in the Ariane V16 launch from January to February may push the actual launch of Phase-3C into September.

AN EYE FOR PERFECTION

COMPUTERS can now think fairly 'straight', make decisions, listen and speak. In fact, there isn't much they can't do.

They are constantly being improved, in an effort to emulate human senses and responses, but are still essentially blind. There has been a great deal of research into visual recognition but with relatively poor results.

"Human vision is hindered by subjectiveness of judgments"

However, whilst being unable to match the human eye in being able to perceive and identify many and varied aspects, they can in some cases offer certain improvements over human sight. Battelle, a US concern, in conjunction with a range of interested companies is to conduct a study of automated visual inspection systems particularly connected with manufacturing industry. Recent developments in sensor technology, electronic image processing, pattern recognition and computer technology is leading the way for further improvements in automated visual inspection.

Gunter Seger of Battelle says that human vision is hindered by the subjectiveness of judgments and limited possibility of standardisation—areas that automation can handle very well. In simple terms, this means that machines can be easily programmed to look for specific faults or characteristics and can do it with great accuracy.

It won't be long before robots take the place of humans in most of the mundane jobs in industry. People and governments now accept this fact. How long will it be, though, before robots take the place of the inventors of robots?

INFORMATION TECHNOLOGY —STILL A LONG WAY TO GO

SCOTTISH Equitable Life Assurance Society (SE) has now introduced a mortgage quotation service located in branch offices and available to insurance brokers and building societies equipped with Prestel equipment. Having had a taste of 'IT', SE have approached Langton Ltd., a consulting firm, with a view to full scale involvement in Viewdata technology. This has resulted in the addition of a personal pension quotation service on Viewdata and the possibility of future linking of their Burroughs mainframe computer, directly into the Prestel network.

SOURCE PACT EXTENDED

SINCE 1981, Philips and Fairchild have operated an alternative source pact which allows each other to produce certain i.c.s designed by the other party. This arrangement has recently been extended to include 90 new high performance FAST TTL (Fairchild Advanced Schottky TTL) devices.

A strong alternative source position is critical to growth of this relatively new TTL family, which is now estimated to be expanding faster than any other TTL line. Although many semiconductor houses do operate similar agreements, there should be more, if future chip shortages are to be avoided. Maybe the answer is an international, multi company technology exchange, each company offering their own designs.

NEW IEC SYMBOLS

THE FINAL publication in a landmark 13-part series dealing with graphical symbols for diagrams will soon be available from the International Electrotechnical Commission (IEC).

This new publication, which is the culmination of several years work on the part of IEC Technical Committee No. 3 —Documentation and Graphical Symbols—provides general information, a general index, and cross-reference tables for the 12 other parts of the graphical symbol series which have been published previously.

Part 1 brings together information needed to use the entire series to its maximum advantage by providing definitions of graphical symbols, their presentation, numbering, and use.

All the symbols presented in this series have been adapted for computer-aided drafting systems. Because these systems require that each symbol have a reference point located at a grid intersection, a transparent grid is supplied with this part of the standard to facilitate the selection of a suitable point.

The now complete 13-part series is a unique tool for users across the entire gamut of the electrotechnology field—from engineeers, to designers, institutions, manufacturers and others. It gathers together world-accepted symbols and graphic component symbols and allows everyone in the electrical and electronic industries to communicate with complete understanding, graphically. Throughout the series, symbols and their alternate acceptable forms are given with explanations in English and French.

AMSTRAD SERVICE

AMSTRAD has announced that 0277 230222 has been designated as the "Customer Service Number" at the company's Brentwood headquarters.

BOOKS AND LETTERS PAGE

Dear Editor

Over many years, I have become an ardent 'taper', including reel to reel, but more especially I refer to cassette tapes, and a means of wiping them clean.

There are many times I would like to clean, i.e. bulk erase, a tape after I have edited off it what I want, and the only method seems to be either to record over the existing stuff, which I don't find satisfactory, I'd rather have a clean start, or to run it at normal speed through a recorder with the record level down low. In which case it is a long job.

I've asked at many stores for a bulk eraser for cassette tapes (which would do my micro cassettes, too), without success. None have I seen advertised, and over the years I've bought other mags than P.E. to see what chances there were.

One is advised to 'keep tapes away from sources of magnetism' so I've held them close to the transformer of my tuner, tape recorder, etc. but haven't had a 'damaged' recording. I thought perhaps a tranny rigged up might make an eraser. No luck.

Can you tell me, can I make one of these, or do you know if there is such a thing available?

Des. H. Reed, N. Yorkshire.

Dear Mr. Reed

Sorry to hear of your problem but we don't know of any such device available. Is the quality of recording over previous material, that bad? If it's only the pauses between recording that you're worried about try a voice activated switch wired to the motor (there's one this month in PE).

Editorial

Dear PE

Can you please help me to find a semiconductor, TIS 151 for the Modular Mixer and Audio Power System project? I have tried all the shops but they have never heard of it.

What rate of speaker can be used for this?

Mr. J. Worton, Surrey.

Dear Mr. Worton,

I was sorry to hear that you have experienced some difficulty obtaining the TIS 151 Darlington transistor specified in the Modular Audio System. These can be obtained from several suppliers (including R.S. Components Ltd.) and cost around 50p.

As regards loudspeaker ratings, any suitably rated loudspeaker system exhibiting an impedance of between 3 ohm and 15 ohm should be ideal. In most cases this will probably comprise several loudspeakers wired together (in series or parallel depending upon the individual impedances) so that the power is suitably shared between them. Two 15 ohm speakers rated at 25W would, for example, be connected together in parallel (taking care to ensure correct phasing) to produce a single loudspeaker system rated at 7·5 ohms-50W.

Wishing you every success with the project,

Michael Tooley, author

Dear Sir

In the October 85 issue of PE, you published a letter from me, where in general I had a moan regarding chip and other semiconductor manufacturers/ distributors and their lack of any interest in a keen hobbiest like myself and thousands more.

Response was very poor in that I still had nothing from that sector, but a couple of individuals wrote to me and helped best they could! One suggested I write to Gothic Crellon, who did indeed send many data sheets. Motorola finally answered the call with a list of sheets and where to get them from (distributors).

One, on the list, was STC who I had tried before, so I tried them again, and then again at their local office, but all to no avail. Motorola say they are a main distributor of goods and DATA SHEETS!! Yet every year they send me their catalogue?? Sorry STC I don't think we will be ordering our goodies from you!!

Could you imagine my surprise when two days ago I received a ring binder from a very kind chap full of very useful data sheets, but the great surprise was this chap lives in Ontario, yes the one in Canada, and so to Brian Deschene many thanks . . . again.

We still needs lots of data sheets and the offer is still open. Four hundred of us want to add various circuits to our home built Z80A computer system, but we will only buy from those who help us.

Are Texas and GI dead???

Mel Saunders, Leicester.

Dear Mr. Saunders (and others)

We are glad that there are some people around who are prepared to go to some trouble to help, but it shouldn't be left to the odd one or two. Come on you big boys (including STC), lend a hand.

Editorial

Dear PE

As I do not take any Electronics magazines regularly, could you tell me if there were any errors in the Mono Stereo Echo Reverb article published Sept '84?

I intend to make the unit for a straight delay (for PA use). Do you know where I can just get the p.c.b.s.

Mr. A. T. Yarnold, Southampton.

Dear Mr. Yarnold

There are no errors in the Echo Reverb that we know of and the p.c.b.s are available from: Becker Phonosonics, 8 Finucane Drive, Orpington, Kent BR5 4ED.

You would, of course, know this if you took PE regularly. We suggest that you keep taking PE or keep taking the pills.

Editorial

MICROPROCESSOR SYSTEMS ENGINEERING

J. Ferguson—Addison Wesley. ISBN 0-201-14657-6

303 pages paperback. £12.95

"Recent trends have shown an explosive growth in the number and complexity of microprocessor applications, accompanied by a sophistication of the hardware and software tools needed to develop and maintain them."

Microprocessor Systems Engineering attempts to gather together in one book all the concepts, skills and practicalities of this diverse and often complicated subject. The first chapter categorises the various forms of microcomputers and details the general aspects of micro based systems.

In chapter two, the fundamentals of four specific processors are dealt with, these being: the 6502, Z80, 8088/8086 and the 68000. The next chapters deal with aspects of software production, testing, debugging and system development. The final chapters deal with such subjects as interfaces and peripherals, LAN's and servicing.

R.M.B

THE TRANSDUCER PROJECT BOOK

Michael J. Andrews—Tab Books Inc. ISBN 0-8306-1992-5

130 pages paperback. £7.95

The Transducer Project Book is suited to the beginner. There is a minimal amount of electronics involved with each project but the principles which are used, are fully explained at each stage.

Transducers, nowadays, are often associated with computers. Most of the projects in this book can be built and used without the need for computer interfacing or indeed a computer. Only a small section is devoted to computer applications.

Projects described include: digital yardstick, sound activated switch, electronic balance, frequency meter and a temperature controlled crystal oven.

F.R.S.

DESIGNING IC CIRCUITS WITH EXPERIMENTS

Delton T. Hall—Tab Books Inc. ISBN 0-8306-1259-0

411 pages paperback. £15.15

This is a useful teaching aid and reference book for beginners through to experienced hobbyists. The first two chapters deal with the concepts involved with i.c.s. and essential electrical and electronic formulas.The following chapters are dedicated to particular types of circuits and i.c.s. including operational amplifiers, phase locked loops and timers. A comprehensive index allows you to find the exact subject you require.

F.B.

SOUND ACTIVATED SWITCH

BY R. A. PENFOLD

Bucket brigade technology coupled with a sound activated circuit provides a useful audio add-on

SOUND activated switches are mainy used in voice operated tape recorders and radio transceivers, but have other uses. Most, if not all, published sound switch designs are of a fairly basic type where the voice signal is simply coupled straight through to the cassette recorder (or whatever). This has a slight drawback in that the first syllable or even the first word is lost each time the switch is activated. This is due to the time taken for such things as the relay to close, the cassette motor to start, and so on. The start-up time obviously depends on the application and the particular equipment used, but is usually quite short at a few tens of milliseconds. The missing part of the signal does not necessarily impair the intelligibility of the signal, although it can do so, but it is obviously undesirable. It can also be accompanied by other undesirable effects, such as pitch variation as the cassette motor goes from zero to full speed.

The loss of voice signal and other problems during the start-up period can be avoided by including a delay line in the signal path so that the voice signal is delayed until the equipment has become fully operational. This sound switch includes such a facility, although it could easily be modified to act as a simple sound switch for non-critical applications if preferred. In fact, with a little ingenuity, the delay-line section could also be used in isolation for delay equalisation in a public address system or something of this nature. The delay is adjustable from a few milliseconds to a maximum of around a tenth of a second. Outputs at a low level (comparable to a microphone signal) and line level are available.

The unit is designed for use with a low impedance dynamic (200Ω or 600Ω cassette recorder type) microphone, and it operates from a 9V or 12V battery supply. The suggested relay will switch loads of up to 5A at 24V d.c. or 240V a.c., which is more than adequate for most liklely applications for the unit.

SYSTEM OPERATION

There is substantially more circuitry in this sound activated switch than in most previous designs, but the additional circuits are those associated with the delay line. Fig. 1 shows the block diagram for the unit.

Dealing with the sound switch section first, the microphone signal is at a very low level of typically under 1mV RMS, and this must be substantially boosted before it can operate a relay driver circuit. A two-stage low noise preamplifier is used, and the voltage gain is adjustable from about 54dB (500 times) to around 74dB (5000 times). This gives an output level in the region of 2V peak to peak to drive the subsequent stages.

One of these is a buffer stage which in turn drives a rectifier and smoothing network. The time constants of these gives a very fast attack time of just a few milliseconds, but a much slower decay time of two or three seconds. The fast attack time is obviously necessary in order to give the delay line a reasonable chance of eliminating the loss of the initial part of the signal. The fairly long decay time is equally important as it prevents relay "chatter", and it also eliminates problems with the relay switching off during brief pauses that occur during normal speech.

The positive d.c. signal generated across the smoothing circuit is fed to a high input impedance d.c. buffer stage which also provides a small amount of voltage gain. This drives a switching transistor which in turn drives the relay coil. A set of normally open relay contacts control the cassette motor or other load. A relay has the obvious disadvantage of being somewhat slower in operation than a semiconductor switching device. However, it still only takes nominally 16ms for the contacts to close, and the complete isolation between the switching contacts and the rest of the unit is often of great importance. A relay can also handle both a.c. and d.c. loads without any problems.

The delay line is a standard CCD (charge coupled device) or "bucket brigade" type. These are based on a series of charge storage capacitors and electronic switches, which are analagous to buckets and humans in a "human chain". The basic action is for the input capacitor to sample the input signal, and then the charge on this capacitor is passed on to the second capacitor in the chain via an electronic switch and buffer amplifier. The input capacitor then samples the input signal

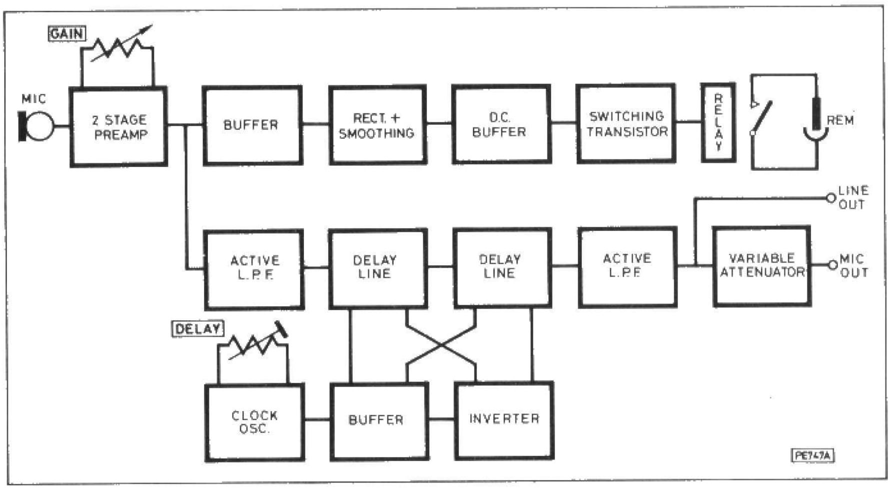


Fig. 1. *Block diagram of the Sound Switch*

COMPONENTS . . .

RESISTORS

R1,R5	1k (2 off)
R2,R3,R11, R20,R21	47k (5 off)
R4	100k
R6,R12	4k7 (2 off)
R7	3k9
R8	2M2
R9,R13, R15–R17, R22, R23–R27	10k (11 off)
R10,R18	22k (2 off)
R14	56k
R19	1k5
R28–R30	8k2 (3 off)
R31	470k

All ¼ watt 5% carbon

CAPACITORS

C1,C4	4µ7 63V radial elect (2 off)
C2,C5,C11	2µ2 63V radial elect (3 off)
C3,C14,C17, C20,C23	1n carbonate (5 off)
C6,C24	1µ 63V radial elect
C7	100n ceramic
C8	100µ 16V radial elect
C9	220p ceramic plate
C10	2n2 carbonate
C12,C15, C18,C21	10n carbonate (4 off)
C13,C16, C19,C22	15n carbonate (4 off)
C25	10µ 25V radial elect

POTENTIOMETERS

VR1	47k lin
VR2,VR3	100k sub-min horizontal preset (2 off)
VR4	1k sub-min horizontal preset
VR5	4k7 sub-min horizontal preset

SEMICONDUCTORS

IC1	TL072CP or LF353
IC2	CA3130E
IC3	4001BE
IC4,IC8	741C (2 off)
IC5,IC6	TDA1022 (2 off)
IC7	1458C
TR1,TR2	BC109C (2 off)
D1,D2	0A91 (2 off)
D3	1N4148

MISCELLANEOUS

S1	s.p.s.t. miniature toggle
SK1	3·5mm jack socket
SK2	5-pin DIN (180 degree) socket
RLA	6V 410Ω coil, s.p.d.t. contacts, open p.c.m. type
B1	9V to 12V (see text)

Printed circuit board PE 102; case about 180 × 120 × 39mm; control knob; battery connector; 16-pin d.i.l. sockets (2 off); 14-pin d.i.l. socket; 8-pin d.i.l. i.c. sockets (5 off); pins; wire; solder, etc.

again, the second capacitor passes on its charge to the third capacitor, and so on, with a continuous stream of samples being taken and passed on through the full length of the delay line to eventually emerge at the output.

This gives an output of the type shown in Fig. 2. The waveform here is not what one might expect, and the problem is due to the final stage of the delay line being unable to simultaneously maintain an output signal and receive the next sample. The output is therefore cut off during the periods when the final stage is receiving samples from the penultimate stage. The amplitude modulated squarewave output could be processed by a lowpass filter to give a proper audio output signal, but very heavy filtering indeed would be needed in order to give an output signal having a really low ripple content. The problem is considerably eased by having an extra stage at the output of the delay line which is used to maintain the output signal level while the final delaying stage receives samples. An adjustable passive mixer stage is used to combine the two output signals for minimal "glitches" on the output. The glitches are not totally eliminated, but they can be reduced to an insignificant level by lowpass filtering. This filtering is essential anyway since the output signal is a stepped waveform, and lowpass filtering is required to smooth out the steps and give a proper output waveform which matches that of the original input signal.

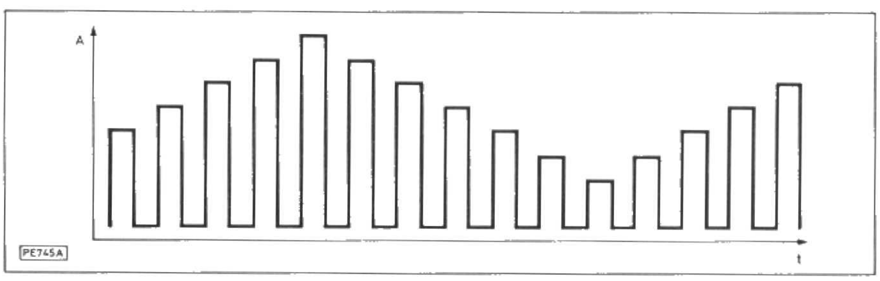


Fig. 2. *CCD output*

DELAY

There are two factors which govern the length of the delay obtained; the number of stages in the delay line and the sampling frequency. In this case we are using two inexpensive CCD chips (TDA1022s) in series, and these provide a total of 1024 delaying stages. An external two-phase clock signal is required, and this is provided by a CMOS astable plus a buffer stage and an inverter to provide the antiphase clock signal. The delay time is equal to the number of delaying stages divided by twice the clock frequency. The clock frequency must be at an absolute minimum of double the maximum input frequency, and it is this that sets the practical limit on the delay time for a given length of delay line. For intelligible speech a minimum bandwidth of about 3kHZ is required, which demands a minimum clock frequency of 6kHZ. With a 1024 stage delay line this gives a delay time of just over 85 milliseconds, which is just about adequate for this application.

A lowpass filter is needed at the input of the delay line to prevent strong signals at frequencies close to the clock frequency from entering the delay line. If this was not done a form of distortion known as "aliasing" distortion would give a very poor quality output. With a clock freqency that is within the audio range a very high slope lowpass filter is needed at the output as strong audible breakthrough of the clock signal would otherwise occur. In this case three 18dB per octave filters in series are used, giving a total roll-off rate of some 52dB per octave. The line output is taken direct from the output of the filter, but the microphone output is taken by way of a variable attenuator which will normally be used to provide about 60dB of attenuation.

THE CIRCUIT

Fig. 3 shows the circuit diagram for the preamplifier, switch, and clock oscillator stages, while Fig. 4 gives the circuit diagram for the delay line and filter stages.

Taking Fig. 3, first, the preamplifier is based on a dual low noise (bifet)

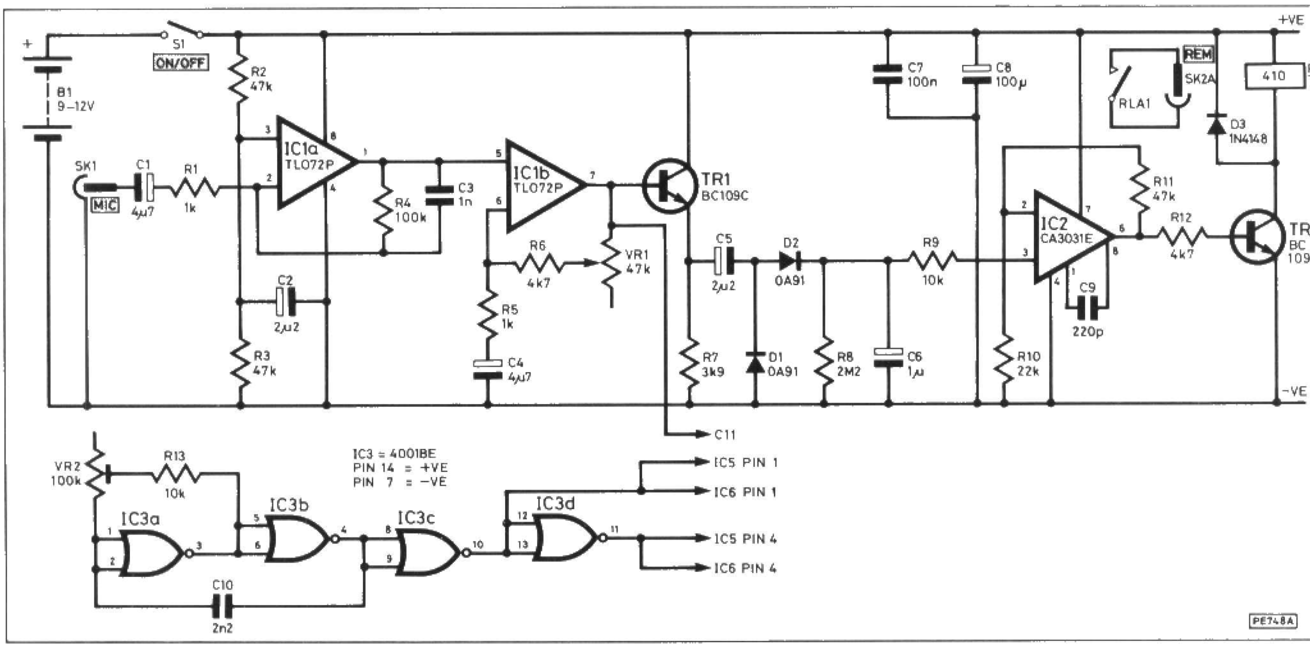


Fig. 3. *Preamplifier switch and clock oscillator stages*

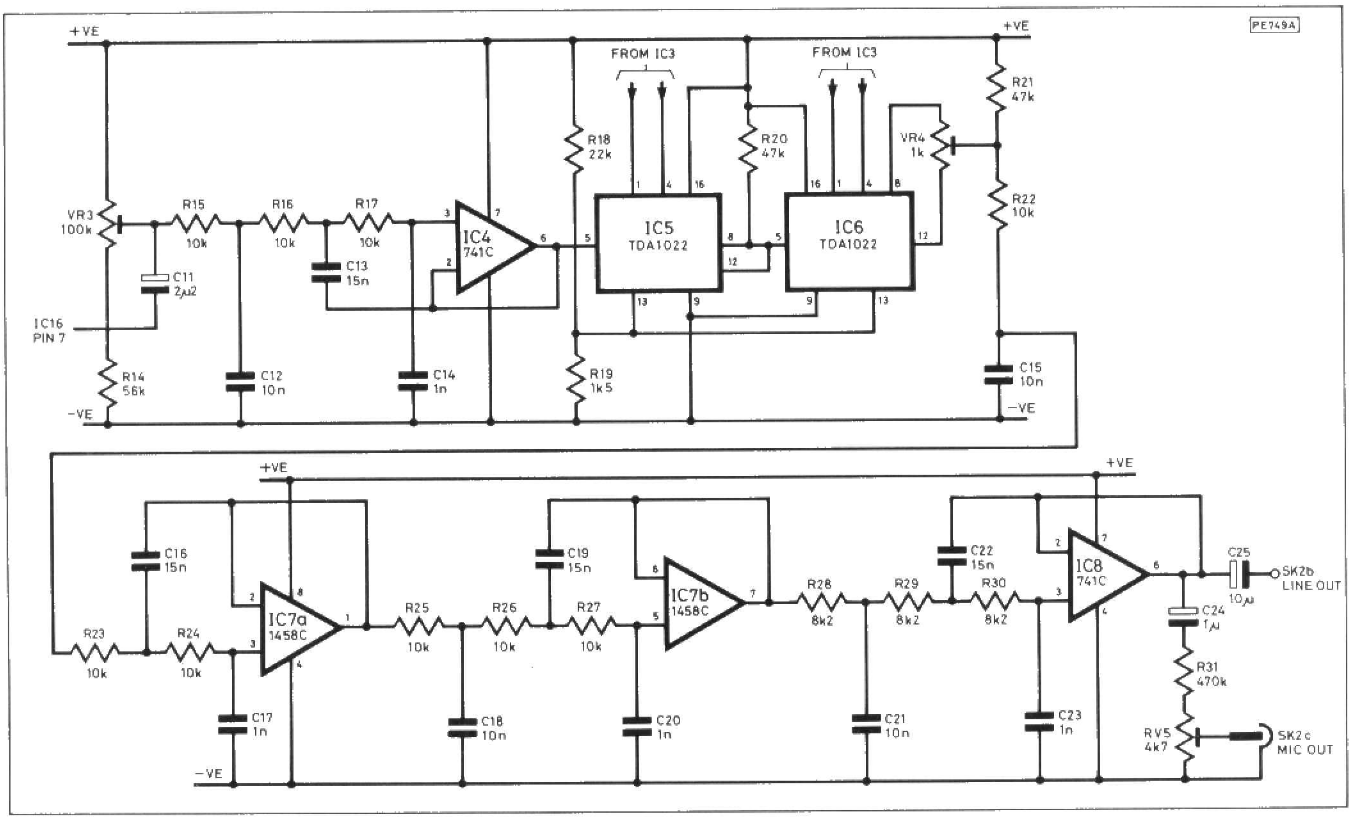


Fig. 4. *Delay line and filter stages*

operational amplifier, IC1. IC1a operates in the inverting mode and has a fixed voltage gain of 100 times. C3 introduces some lowpass filtering which helps to avoid serious aliasing distortion, but is of no real consequence as far as the switch section of the circuit is concerned. IC1a has its output direct coupled to the input of IC1b, which operates in the inverting mode with a voltage gain that is variable from 5·7 times to over 50 times by means of VR1. The signal for the delay line is taken from the output of IC1b, but the signal which drives the switch circuit is taken via the emitter follower buffer stage based on TR1. The latter is needed primarily to prevent the rectifier and smoothing circuit from placing non-linear loading on IC1b and causing distortion.

The rectifier is a straightforward two-diode half-wave type, with smoothing provided by C6. The low output impedance of TR1 coupled with the fairly low value of C6 gives a suitably fast attack time, while the high value of R8 gives only a high resistance discharge path and a relatively long decay time. IC2 is the d.c. buffer stage, and this is an operational amplifier connected in the non-inverting mode. Negative feedback resistors R10 and R11 give a low voltage gain of only about three times. IC2 is a CA3130E, and this has a CMOS output stage that enables a peak to peak output voltage virtually equal to the supply potential to be achieved. This is important in

this application as it enables the output of IC2 to go sufficiently negative to switch off the relay driver transistor, TR2. Most operational amplifiers are not suitable for use in this circuit as they would hold TR2 permanently in the on state. IC2 also has a MOS input stage which gives a very high input resistance and ensures minimal loading on the high impedance smoothing circuit. IC2 lacks an internal compensation capacitor, and discrete component C9 is required.

The chosen relay has a fairly high coil resistance so that the current consumption of the unit is kept down to reasonable proportions while the relay is activated, and battery operation is a realistic proposition. D3 is the usual protection diode to suppress the reverse voltage spike generated as the relay switches off.

IC3 is a CMOS 4001BE quad 2 input NOR gate, but here all four gates are wired to operate as simple inverters. IC3a and IC3b are connected as a standard CMOS astable circuit, and VR2 can be used to vary the clock frequency over wide limits. IC3c acts as the buffer stage and IC3d is the inverter which generates the second clock phase.

The input filter is a conventional third order (18dB per octave) type which has IC4 as the unity voltage gain buffer stage. VR3 provides a variable input bias for this stage, and due to the use of d.c. coupling throughout the delay line circuits it actually provides the bias voltage for all the subsequent stages as well. VR3 is adjusted to provide optimum large signal handling, and an output level of several volts peak to peak can be provided before the onset of clipping occurs.

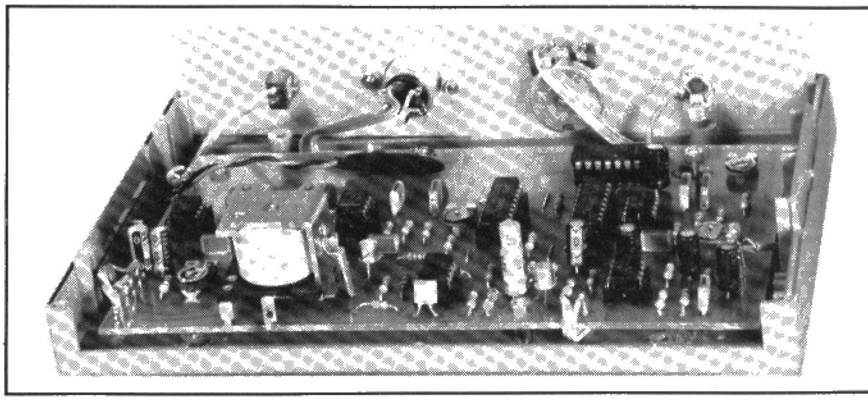


Photo 1. *Internal details of the Sound Activated Switch*

Apart from the clock oscillator and filters little in the way of discrete components are required for the delay line chips (IC5 and IC6). R20 and R21 are load resistors for the output stages of these chips. The two outputs of IC5 are simply wired together and coupled direct to the input of IC6. VR4 provides mixing at IC6's outputs, and VR4 is adjusted for minimum clock breakthrough at the output. R18 and R19 provide a small bias voltage for an input on each delay line chip.

The three output filters are identical to the input filter apart from the final one. This only differs in that the filter resistors have been made slightly lower in value, which slightly improves the overall response of the filters. R31 and VR5 form the variable attenuator at the microphone output of the unit.

CONSTRUCTION

Except for the controls, sockets, and battery, all the components fit onto the printed circuit board. The printed circuit track pattern and component layout are illustrated in Fig. 5.

Although construction of the board is largely straightforward there are a few points that should be noted. IC2, IC3, IC5 and IC6 are all MOS devices which should be fitted in holders, and the other normal antistatic handling precautions should be observed. D1 and D2 are germanium devices which are more easily damaged by heat than silicon types. Take care to avoid overheating these when soldering them in place. From the electrical point of view any 6V relay having a coil resistance of about 20Ω or more and adequate contacts is suitable for use in this

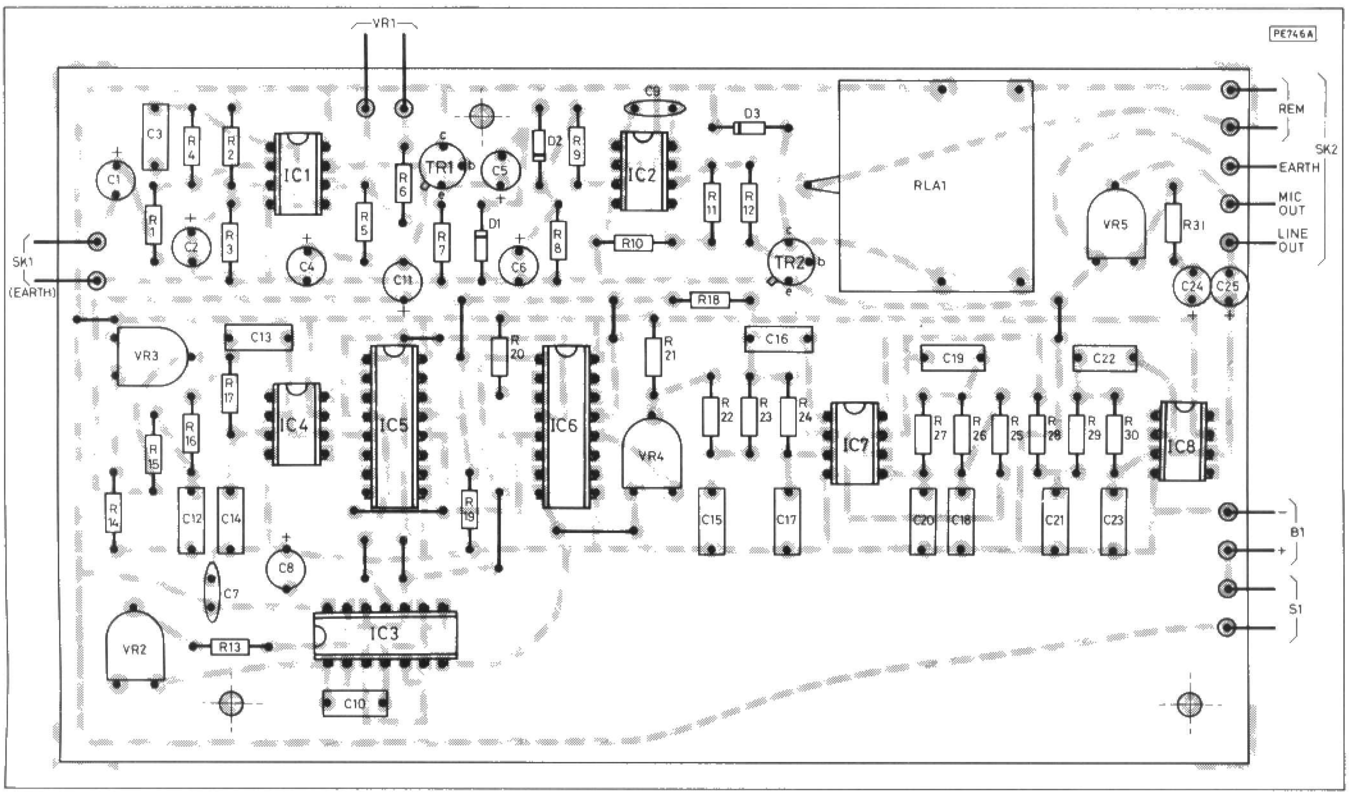


Fig. 5. *P.c.b. pattern and component layout*

circuit. It is best to use the specified type though, since it will fit direct onto the board. Alternatives, even printed circuit mounting types, would either need to be mounted off-board somehow, or the board would have to be modified to suit the different pin-out arrangement. The filter capacitors must be carbonate types, or polyester types of the same small physical size and 5% tolerance.

The case for the prototype is a plastic type having metal front and rear panels and approximate outside dimensions of 180mm x 120mm × 39mm. This is just sufficient to accommodate all the parts including a PP3-size NiCad battery. If a non-rechargeable battery is used a fairly high capacity type will be required due to the quite high current consumption of the unit. This is approximately 8 milliamps under quiescent conditions, but rises to 30 milliamps or so when the relay is activated. A PP9-size battery or six HP7 cells in a plastic holder are suitable. However, this would probably necessitate the use of a slightly larger case. The TDA1022 delay line chips have a minimum recommended supply voltage rating of 10V, but it does not seem to be essential to resort to a 12V battery supply, and good results are obtained using an ordinary 9V battery as the power source.

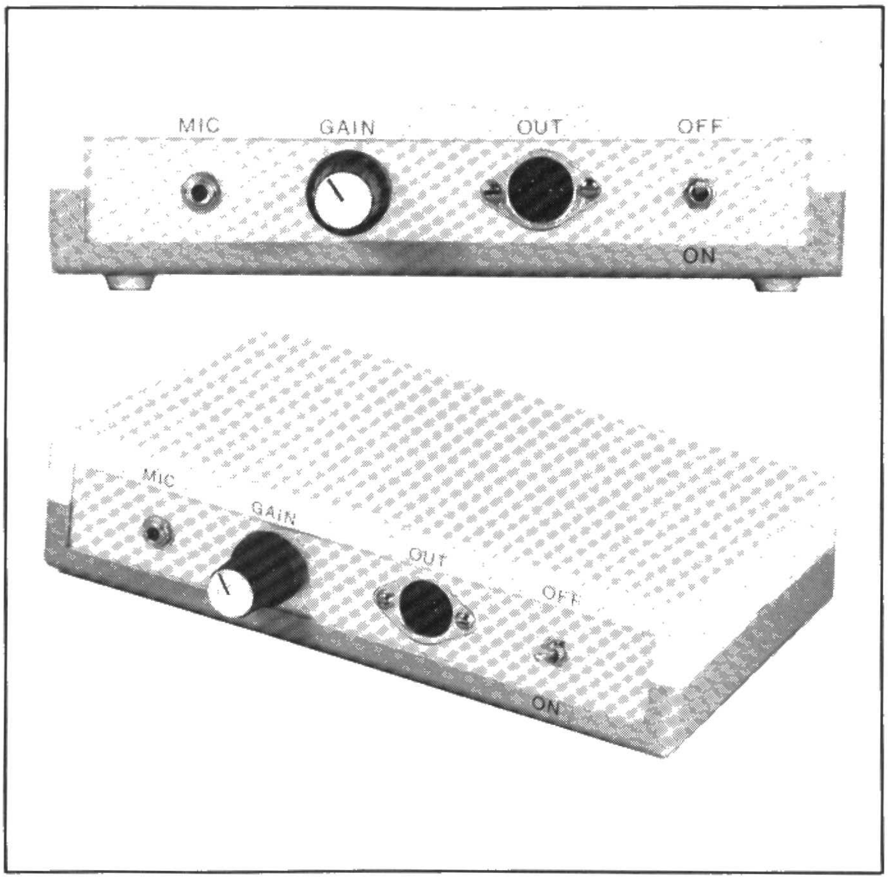


Photo 3. *Front panel and case details of the Sound Activated Switch*

The controls and sockets are mounted on the front panel, and the printed circuit board is fitted on the base panel using M3 or 6BA fixings. The hard wiring is then added. A screened lead is used to connect SK1 to the board, but the other leads are made from ordinary multistrand PVC insulated connecting wire. SK2 is a 5-way DIN type on the prototype, but obviously any more convenient type can be substituted here, or separate "line", "mic. out", and "remote" sockets can be used.

ADJUSTMENT

With all four prestet resistors set at roughly a middle setting the unit should work reasonably well. VR3 can be adjusted with the aid of an audio sinewave generator and an oscilloscope to give symmetrical clipping, or if suitable test gear is not available it can be given any setting that enables a high output level and low distortion to be achieved.

VR2 enables the delay time to be adjusted, and this is set for the longest delay that is commensurate with good audio quality. Anticlockwise adjustment gives increased delay time incidentally. VR4 is simply adjusted for minimum breakthrough of the clock signal at the output. VR5 is adjusted to give an output level from the microphone output that is comparable to that obtained from the microphone normally used with the controlled equipment. VR1 controls the sensitivity of the unit, but it also affects the output level of the unit. VR1 should therefore be set at a practical setting before adjusting VR5. Avoid having the sensitivity too high for the microphone in use as this will simply result in clipping of the output signal and unwanted triggering of the unit by background sounds. It is useful to have the sensitivity control as a front panel control as it is then easy to adjust it to compensate for changes in the distance from the speaker to the microphone, and different microphones if more than one type is used with the equipment. PE

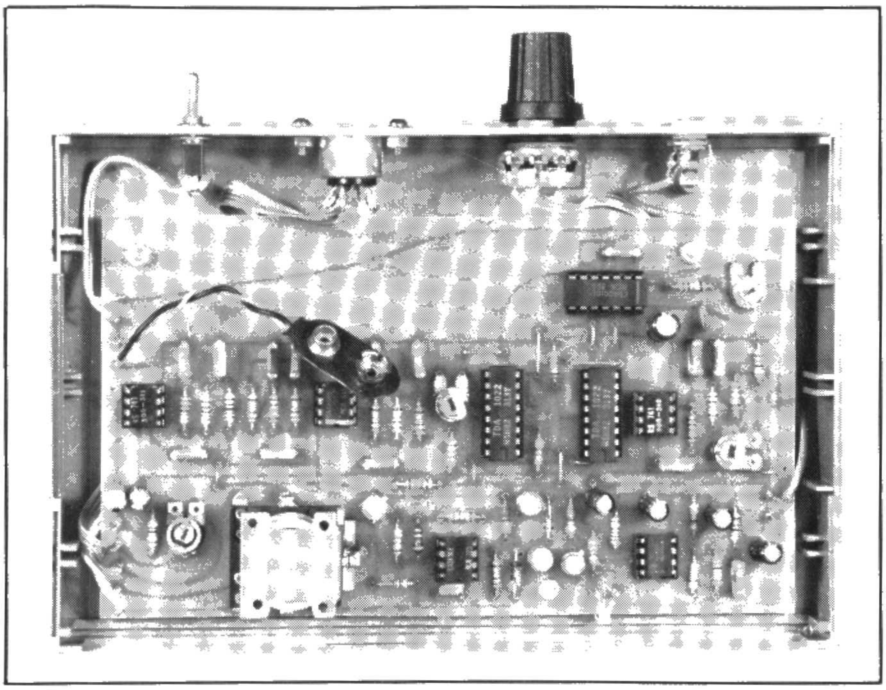


Photo 2. *P.c.b. component layout details*

THE LEADING EDGE

BY BARRY FOX

The technology behind the technology and things to come

It is hard now to sell anything in the professional or domestic audio industry unless it carries a "digital" label. Studios use digital tape to record music, which is then issued on compact disc, the 12 centimetre digital gramophone record which is read by a laser. The compact disc system is now so successful that the supply of records cannot meet the demand.

The computer industry will soon start selling CD peripherals because one CD can store 600 megabytes of data, equivalent to around 1000 floppies. The data is read-only, of course. The disc becomes an extra ROM of hitherto undreamed-of capacity. Hence the term CD ROM. It's cheap, too. A CD ROM disc costs no more to make than a music disc. As far as the disc pressing plant is concerned it makes no difference what the spiral track of sub-micron bits carries in code.

CD ROM players will be cheap, unless the computer firms profiteer. Already CD music players are selling for under £200. The raw kit of parts, chips and optics, cost manufacturers under £50 and much less in bulk. A CD ROM player does not even need the digital-to-analogue converter chip needed for music reproduction.

It is easy to transfer books and maps onto CD ROM, because the text and line structure is usually in digital code already. Modern printing presses run from an input of ASCII code on tape. The code can just as well be fed to a compact disc mastering suite. Philips has put a Dutch dictionary on CD ROM as a test. In America the Grolier publishing house has put all 21 volumes of its encylopaedia on a single $200 CD ROM. A PC database can search out entries, with access time of less than a second.

DEVELOPMENTS

New developments now follow so fast that the technical basics on which they rely get lost in a sea of commercial puff.

Compact disc sound is in pulse code modulation or PCM. The original signal is sampled at 44·1KHz and each sample described in a 16-bit word. The digital pulses or bits are recorded as a track of 15 billion pits in a 4·5 kilometre spiral track on the 12 centimetre disc. The pits are 0·1 micrometre deep and 0·6 micrometre wide. The track has a 1·6 micrometre pitch and the read-out laser is accurately focused by servo control to a one micrometre spot. By comparison a conventional vinyl LP has a groove around 50 micrometres wide, similar to a human hair, and is tracked by a diamond stylus with a curved tip of 15 micrometres radius.

Currently there are only ten factories around the world capable of pressing compact discs on a commercial scale. Although their claimed production totals nearly 100 million discs a year, only around 50 million discs a year have so far been reaching the market. Four million people round the world now own CD players and shop prices have risen to over £10 a disc. Philips of Holland has signed a joint venture deal with Dupont of the US, to press 200 million discs a year by 1990.

CODING

Although the CD format specifies 16-bit coding, Philips has been selling players since the system launch in 1983 which rely on only 14-bit decoders. Despite this, most hi fi buffs think the Philips players sound better than Japanese players which use 16-bit chips. This follows from a clever decoding trick.

Philips argued when CD was launched that 16-bit technology was not ready. Chips do not resolve the fine detail available from the last two bits. So Philips research laboratories in Eindhoven developed a technique called over-sampling which makes 14-bit chips behave like 16-bit chips.

Oversampling spreads unwanted noise over an artificially widened sound spectrum. The digital data leaves the disc in a stream running at 4·3 megabits/second. To reconstitute the original analogue waveform, the player would normally work on 44,100 samples a second to match the original 44·1kHz coding. Instead the Philips player feeds the 16-bit data stream into a shift register which quadruples the sampling frequency, so that three dummy bits are created for each bit which matters.

INCREASE SAMPLING

When the sampling frequency is quadrupled, from 44·1KHz to 176·4KHz, the effective audio bandwidth is also quadrupled, from 22KHz to 88KHz. There is of course no audible signal outside the original 22KHz bandwidth, but the unwanted background noise produced by the digital system is now spread over the full 88KHz range. So 75% of the noise is above the range of normal hearing and can be removed by filtering. This reduction of noise compensates for the introduction of noise by the use of 14-bit chips instead of 16-bit chips.

There is an added benefit. Because the noise filter can operate over a very wide band of audible frequencies, it can operate on a smooth slope. Sharp action filters, which try to chop off everything immediately above the audio range, introduce audible "ringing" distortions of their own.

OBVIOUS

For three years now audio engineers have been asking the obvious question. How would a genuine 16-bit chip sound with four times oversampling? In theory the performance becomes equivalent to 18-bit. Philips has been promising to launch a 16-bit oversampling player for the best part of a year now. They were due in the shops last autumn. Then late 1985. Then early 1986. Even as Philips' adverts for 16-bit players appeared in magazines, and as Philips' UK subsidiary Mullard offered 16-bit chip packages for sale to other manufacturers, Philips put the project on hold. The chips don't yet work properly. Resolution is nowhere near 16-bit, because the chip cannot resolve all the small signal steps accurately. The resolution may vary too, with time and temperature. Foolishly Philips released a prototype 16-bit player for review. The reviewer measured performance and found it poor. Production at Philips' factory in Hasselt, Belgium was postponed yet again. If nothing else it proves Philips' point of three years ago; namely that

(continued on page 39)

SETTING THE STANDARDS

BY RICHARD BARRON

Two micro-system back plane standards—the STEbus and the PE Hobby bus

THE electronics hobby has changed dramatically in recent years, largely due to the influence of LSI digital i.c.s and inexpensive personal computers. It was inevitable that cheap micros would give a new dimension to the hobby; providing new challenges as software engineering and computer applications projects became as much a part of amateur construction as radio receivers and power supplies.

However, whilst home micros have indeed given rise to the appearance of countless digital and analogue projects, interfaces and controllers, they have also created a number of problems, not least of these being compatibility. A multi-channel mains controller designed for a particular micro will, probably, not work with another computer.

This problem is not unique to the electronics hobbyist but is common to industrial and commercial designers. Printers, plotters, disc drives and monitors are often designed, exclusively, for one type of machine, and in many cases, cannot be used with different models. Sometimes, this is intentional as it can be good marketing strategy to sell a low cost but powerful computer which, on the face of it, seems an attractive package. Many people do not realise the pit-falls of exclusive add-ons until too late. They become a captive audience to a single range of accessories.

Similarly, in the manufacturing industry, robots, automated manufacturing systems, various control systems and a multitude of other devices are now available which may only be installed to certain and exacting specifications.

SOLUTIONS

Despite widespread awareness of the problems which confront the industry, solutions which provide compatibility have not, as yet, been widely accepted. And, in many cases, new standards have, themselves, created further problems or restrictions. For example, a group of mainly, large, Japanese companies including Hitachi, Mitsubushi and Toshiba, under the guidance of Microsoft (the software house), introduced the MSX standard. This standard was intended, primarily, to ensure software compatibility between machines manufactured by different companies, and secondly to standardise hardware facilities. To a large extent, the software solution was successful, despite a few minor problems. The same is true for the hardware approach; compatibility of peripherals was achieved. But, inherent restric-

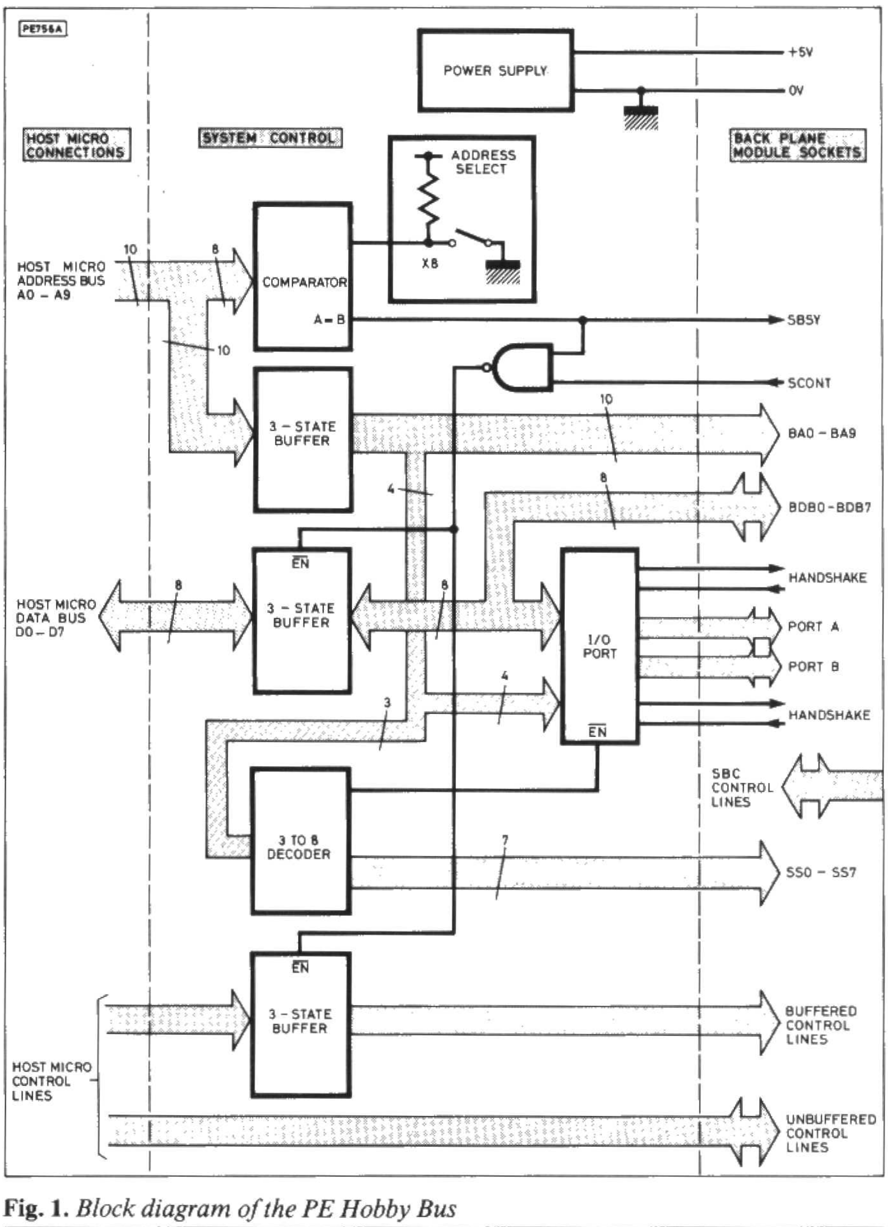


Fig. 1. *Block diagram of the PE Hobby Bus*

Table 1. *Compatible micros*

COMPUTER	PROCESSOR
ZX81	Z80
ZX SPECTRUM	Z80
BBC	6502
MSX	Z80
COMMODORE	6502
VIC-20	6502
AMSTRAD	Z80
RML	Z80
VARIOUS	6502
VARIOUS	Z80

tions in the design parameters meant that MSX machines are limited, and are unable to take advantage of more advanced technology and new developments.

Other examples of standardisation in the computer industry are those of communications protocols, such as the RS232 serial link and the parallel IEEE488. These two standards have, in fact, been widely accepted.

Many peripherals, particularly printers, are quoted as being IEEE488 compatible. Even so, it seems that there are still problems. Although the various signal standards are clearly defined, it has become apparent that manufacturers have not yet agreed on the type of connection leads, connectors or colour codes. The results are obvious.

Clearly, therefore, there are two important lessons to be learnt from these examples. Firstly, design standardisation should not impose unneccesary restrictions upon future developments. Secondly, standards should be clearly defined, allowing no room for ambiguity. With this criteria in mind, PE has decided to adopt two clear standards in an effort to provide readers with many advantages without sacrifice to flexibility or future development possibilities.

Our two standards will feature extensively in future projects and articles, and should prove interesting to all readers, whether hobbyists or professionals, actively engaged in the industry.

Designs for interfaces and peripherals will, for the first time, be compatible with almost any home micro. No longer will speech synthesisers designed for the Spectrum be useless to BBC owners. Even if you don't already own a computer, our inexpensive SBC projects will allow you full control over an enormous range of micro projects.

PE HOBBY BUS

The PE standard interface for all home micros

Over the last few years, PE has published a large selection of computer projects including speech synthesisers, amplifiers, robot and printer interfaces, and digital and analogue ports. It's unfortunate that they, all, could not be used with a variety of host micros. Each project was dedicated to one particular machine, yet with a little thought could have been modified to suit most others.

By their very nature, computer ports and peripherals are very much alike, regardless of manufacturer or CPU employed. All home micros have an address bus, data bus and a number of control lines. Some have standard I/O ports. The differences between machines are usually minor obstacles to compatibility, such as I/O address space, bus connectors or program languages.

The PE Hobby Bus Standard is designed to allow for these minor differences and permit almost any machine to have full control over a wide range of peripherals and interface devices.

FLEXIBILITY

A block diagram of the PE Hobby Bus is shown in Fig. 1. A flexible I/O section provides buffering of address and data lines and input/output decoding. The spare I/O area for any host micro may be set up via only a few switches, giving enormous software and hardware flexibility. A short list of compatible micros is given in Table 1.

Also included, as standard, on the Hobby Bus, are 16 I/O lines plus four handshake lines which can be accessed from any position along the bus. These lines may be used in conjunction with a range of peripherals and can be controlled by any host micro.

In addition to the standard I/O lines, a further seven decoded Select lines are available, which together with the buffered control lines permit almost any type of device to be connected. A few of the planned devices which may be supported by the Hobby Bus are shown in Table 2.

Table 2. *Support projects*

PROJECTS	ISSUE
SPEECH SYNTH	TBD
ANALOGUE PORT	OCTOBER
BATTERY BACKED RAM	TBD
MINI PRINTER	TBD
ROBOT/SERVO CONTROLLER	TBD
SBC-1	JUNE
KEYBOARD/DISPLAY MODULE	JULY
EPROM PROGRAMMER	TBD
TBD = To Be Decided	

BACKPLANE

The PE Hobby Bus system is based around a 64-line backplane which allows up to seven uniquely addressed modules to be connected as well as a selection of other devices such as SBC's, PSU's or memory cards.

Modules are connected to the system via DIN 41612 standard, 64-way a-c, connectors. The module p.c.b.s are standard size Eurocards (100mm × 160mm) and module I/O connections are made via 15-way, D-type connectors. All components will be widely available and by using standard items, cost will be kept to a minimum. A schematic representation of the backplane and module sockets is shown in Fig. 2.

The on-board power supply, supplies 5V d.c. at around 750mA. This should be sufficient for most applications but should more current be required, this can be achieved via a plug-in module. Additional lines have been designated for other voltages for op-amp supplies, programming voltages and power fail requirements.

CONNECTOR PIN ALLOCATIONS

All of the designated signal lines are listed in Table 3. A brief description of some of their functions is given below.

BA0–BA9: These are the least significant 10 address lines. All connections

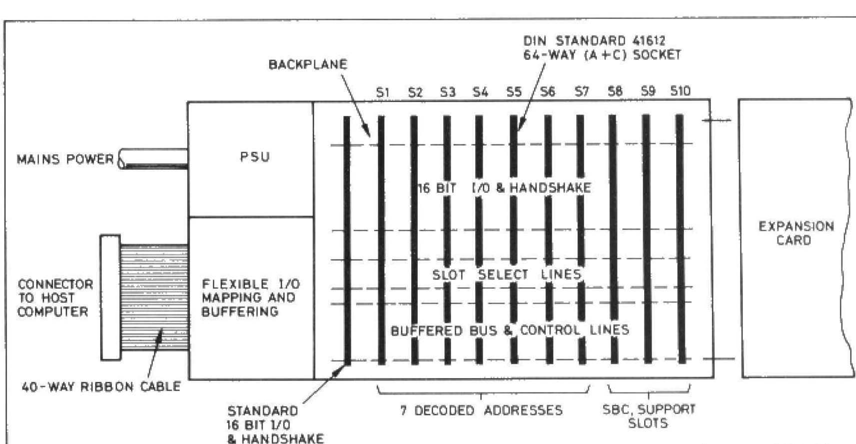
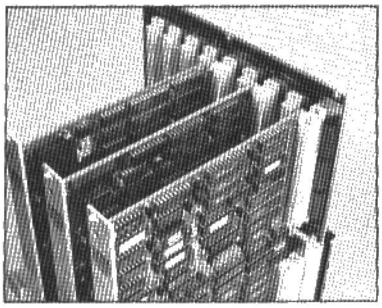


Fig. 2. *Block diagram of the backplane*



An industry standard backplane employing double Eurocard connectors

to these lines should be via three-state buffers.

DBB0–DBB7: These are the data transfer lines and are bi-directional via three-state buffers.

I/O A and I/O B: These are two 8-bit I/O ports and may be used to communicate with other modules or control peripheral devices. Strobe lines are also available.

SCONT: The System Control line is used to give bus control to any other modules, especially SBC's which may be used to control the Hobby Bus.

SBSY: This line indicates that the host micro has control of the bus.

SS0–SS7: These are the Slot Select lines used to select a particular module position (slot) on the bus. It should be noted that they are not available at all connector points. Seven connectors are designated as slots. Thus, Slot 1 would have SS1 available at pin 6, Slot 2 would have SS2 available at pin 6, and so on, up to Slot 7.

Next month we will publish Part 1 of the constructional series based on the PE Hobby Bus. This will include the complete circuit diagram and further details of system operation.

THE STEbus (IEEE 1000)
The 8-bit IEEE standard for all 8-bit processors

The STEbus is the only available 8-bit bus on a single Eurocard likely to gain full IEEE approval. It is now in the final stages of becoming the IEEE 1000 standard.

The IEEE 1000 bus was designed by engineers for engineers and was the result of a growing need for a compatible and flexible bus standard which could offer reliability and acceptance. As it now stands, the STEbus has become the one truly manufacturer independent standard, as a result of a team effort, from a number of engineers and consultants, from a variety of organisations. There are now manufacturers and distributors of STE products throughout the world, including the UK, Europe and the USA.

Table 3. *PE Hobby Bus System connection details*

PIN	A		B	
1	0V		0V	
2	12V		−12V	
3	BA4	BUFFERED	BA5	BUFFERED
4	BA6	ADDRESS	BA7	ADDRESS
5	BA8	LINES	BA9	LINES
6	SS1–SS7 (SLOT SELECT)		SCONT (SYSTEM CONTROL)	
7	SBSY (SYSTEM BUSY)		INT	
8	BDB0	BUFFERED	BDB	BUFFERED
9	BDB2	BI-DIRECTIONAL	BDB	BI-DIRECTIONAL
10	BDB4	DATA BUS	BDB	DATA BUS
11	BDB6		BDB	
12	BA0	BUFFERED	BA1	BUFFERED
13	BA2	ADDRESS LINES	BA3	ADDRESS LINES
14	I/O A0		I/O A1	
15	I/O A2	I/O	I/O A3	I/O
16	I/O A4	PORT A	I/O A5	PORT A
17	I/O A6		I/O A7	
18	ASTB (PORT A STROBE)		ARDY (PORT A READY)	
19	I/O B0		I/O B1	
20	I/O B2	I/O	I/O B3	I/O
21	I/O B4	PORT B	I/O B5	PORT B
22	I/O B6		I/O B7	
23	BSTB (PORT B STROBE)		BRDY (PORT B READY)	
24	$\overline{\text{WAIT}}$		$\overline{\text{NMI}}$	
25	$\overline{\text{RESET}}$		$\overline{\text{HALT}}$	
26	* RD/$\overline{\text{W}}$ (READ/WRITE LINE)		* 10RQ/Ø2 (I/O REQUEST CLOCK)	
27	* MREQ/RD (I/O CONTROL)		* SYNC/M1 (I/O CONTROL)	
28	$\overline{\text{SBC INT}}$		$\overline{\text{SBC WAIT}}$	
29	$\overline{\text{SBC RESET}}$		$\overline{\text{SBC NMI}}$	
30	$\overline{\text{SBC HALT}}$		PSUMON (PSU MONITOR)	
31	V_{STBY} (STANDBY POWER)		V_{PGM} (PROGRAM SUPPLY)	
32	+5V		+5V	

Table 4. *STEbus connector pin designations*

PIN	A	B
1	0V	0V
2	+5V	+5V
3	D0	D1
4	D2	D3
5	D4	D5
6	D6	D7
7	A0	0V
8	A2	A1
9	A4	A3
10	A6	A5
11	A8	A7
12	A10	A9
13	A12	A11
14	A14	A13
15	A16	A15
16	A18	A17
17	CM0	A19
18	CM2	CM1
19	ADRSTB	0V
20	DATACK	DATSTB
21	SYSERR	0V
22	ATNRQ0	SYSRST
23	ATNRQ2	ATNRQ1
24	ATNRQ4	ATNRQ3
25	ATNRQ6	ATNRQ5
26	0V	ATNRQ7
27	BUSRQ0	BUSRQ1
28	BUSAK0	BUSAK1
29	SYSCLK	+VSTBY
30	−12V	+12V
31	+5V	+5V
32	0V	0V

Because of its popularity and acceptance in industry, PE has decided to adopt the IEEE 1000. There are already 100's of products available for the standard including SBC's, digital and analogue cards, power supplies, memory cards and disk controllers. As well as these, PE will be publishing a number of designs which will all be compatible.

BUS FEATURES

The STEbus works with any 8-bit microprocessor using both synchronous and asynchronous, non-multiplexed data transfer. It has a multi-user capability with eight attention request levels and an interrupt acknowledge cycle. Up to 1Mbyte of memory can be addressed with 8-bit data transfer at 5–6MHz bandwidth.

Power supply requirements are +5V, 0V and ±12V. All the signal and power lines are available on a 64-way backplane with 64-way a and c connectors conforming to DIN standard 41612. The module cards are based around a single Eurocard (100mm × 160mm) format and completed assemblies may be mounted in 19 inch rack systems. A complete list of STEbus Signals and pin designations is shown in Table 4. These will be described in greater detail in forthcoming projects. PE

STE-BUS POWER SUPPLY

BY FARIBA SANIEENEJAD

An STE compatible PSU with extra features including battery back-up and variable o/p

The STEbus power supply requirements are: +5V, ±12V, 0V and Vstby. Current limits are not dictated in the standard, but are left to user requirements. Since the bus is designed to facilitate logic-based cards and modules, the 5V rail will cater for the greatest current demand.

The dual 12V supply will probably be used for analogue circuits and the stand-by rail for low current back up of static RAM. In addition to the specified power rails, in this design, to cater for EPROM programming, an additional variable voltage supply is available. The specifications of the p.s.u. are shown in Table 1.

Table 1. *P.s.u. specifications*

	I_{max}	V_{out}	Regulation
5V	2A	5V	10mV
+12V	200mA	+12V	0·4%
−12V	200mA	−12V	0·4%
V_{stby}	100mA	5V	0·2%
V_{pgm}	100mA	2V–24V	0·1%

DESIGN CONSIDERATIONS

Whilst many of the commercially available p.s.u.s for the STEbus may be of advanced technical design (often switch mode operation), the emphasis in this project lies in simplicity and reliability. Voltage regulation is achieved through the use of standard, readily available components.

As the unit is designed, primarily, to power microprocessor based circuits, a toroidal transformer was used, which offers low noise and EMI characteristics, and obvious size advantages. The cost of these devices is almost down to that of traditional transformers.

The PE P1000 Standard constructional series is based around a 19 inch Eurocard sub-rack system which is available from a number of suppliers. However, it is not absolutely necessary to use this system, as a simple back plane and separate p.s.u. will do the job, but at the expense of a professional finish. If the sub-rack system is adopted, then this project will fit, snugly, into a 20E Eurocard module, giving an extremely neat appearance. The sub-rack system and slide-in module is shown in Photo 1 (part assembled) and Photo 2 (assembled). In both, the back plane is not shown. More will be said about Eurocards and sub-racks in Part 2, next month.

CIRCUIT OPERATION

Fig. 1. shows the complete circuit diagram of the P1000 Standard Power Supply Unit. T1 is fed from the mains via a two pole, on/off switch which may be used to power down the system. The secondary winding of T1 is centre tapped to provide 18V RMS + 18V RMS via a semi delay 3A fuse. A semi delay type was used to allow for current surges on power up.

REC1, rectifies the low voltage a.c. to give approximately 36 × 1·41V (RMS conversion factor ≈1·41) peak to peak. This is equivalent to plus and minus 25·5V peak with respect to the centre tap, 0V. C1–C3 provides smoothing giving an unregulated d.c. supply with a small (hopefully) ripple content depending upon the current demand of the unit.

The ±12V supplies are straight forward in their operation, relying simply on IC3 and IC5, 78 and 79 series regulators. Although these devices are capable of supplying up to about 1A, with suitable heat sinks, the ±12V

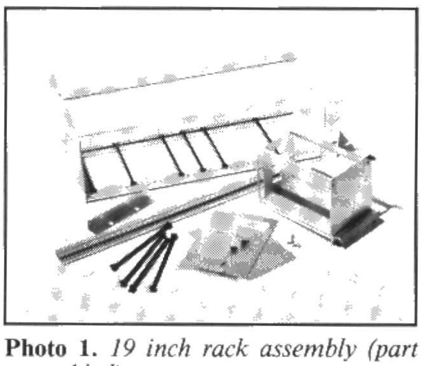


Photo 1. *19 inch rack assembly (part assembled)*

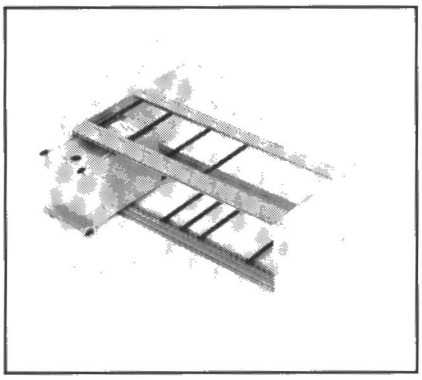


Photo 2. *19 inch rack assembly and module*

supply in this design, is only intended to supply around 200mA. Keeping to this limit, no heat sinks are required as the maximum power developed in them will be about 2·8W, which is well within their dissipation capabilities.

As said previously, most of the current taken from the supply will pass through the 5V regulator. To reduce the power requirement of this device, it is fed via a 3·3Ω, 17W resistor, R3. As more current flows through the regulator and thus the resistor, the potential across IC1 decreases thereby limiting the power developed.

Also to keep the temperature of the regulator down to an acceptable level, a 5°C/W heat sink is used. IC1 is internally protected but as an added precaution to protect both the p.s.u. and the load, a 2A fuse is included in the output.

PROGRAMMING AND STANDBY VOLTAGES

An adjustable 'programming' voltage (2–24V) is supplied via IC4, an LM317L variable voltage regulator which is capable of supplying up to 100mA. The output is adjusted by VR2 and is given by:

$$V_{out} = 1{\cdot}25\ (1 + VR2/R8)$$

The Vpgm voltage should be preset to the required level for a specific purpose, such as 21V for certain types of EPROM.

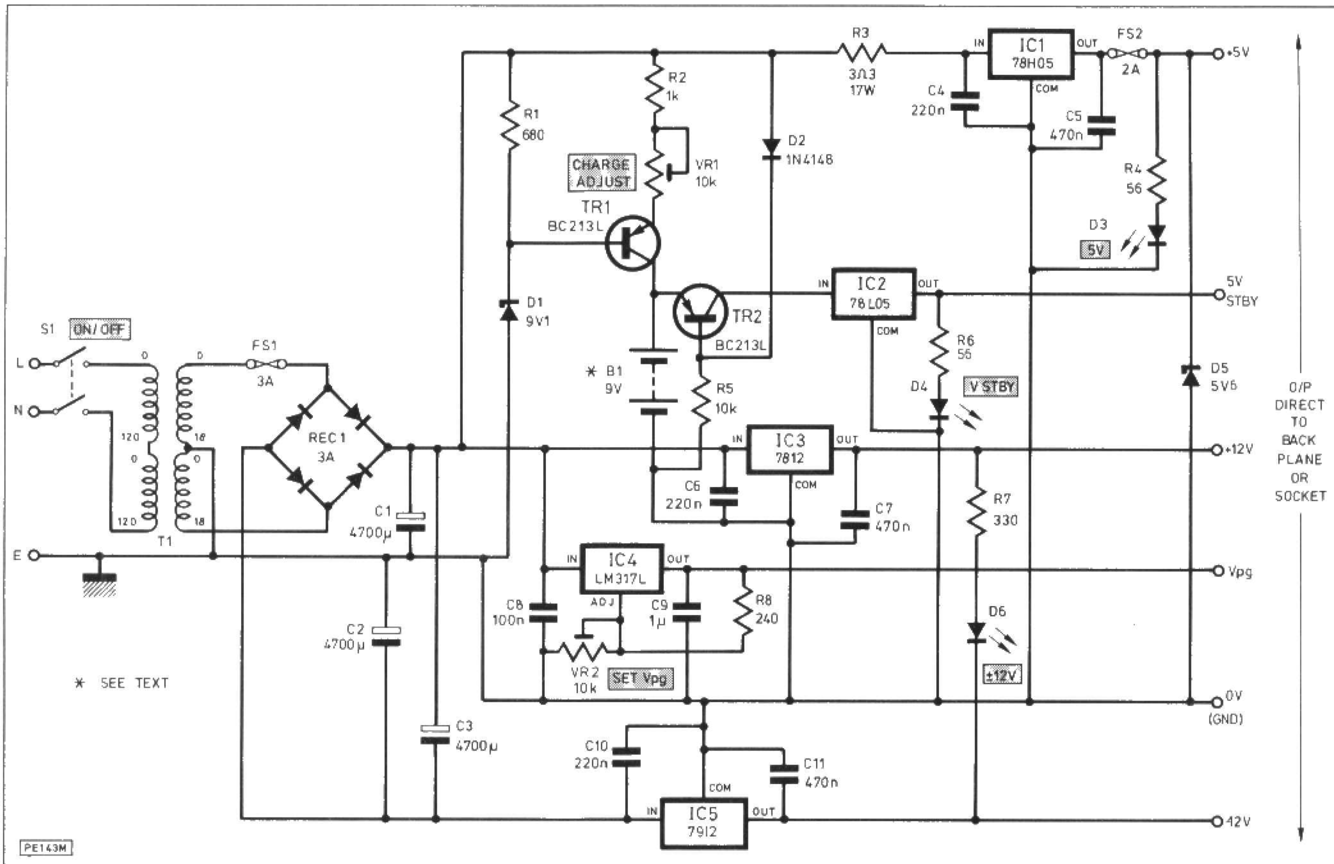


Fig. 1. *Complete circuit diagram of the PE STEbus p.s.u.*

COMPONENTS . . .

RESISTORS

R1	680
R2	100
R3	3Ω3 17W
R4,R6	56 (2 off)
R5	10k
R7	330
R8	240

All ¼W unless stated otherwise

POTENTIOMETERS

VR1	1k min trimmer
VR2	10k min trimmer

CAPACITORS

C1,C2	4700μ 25V elect. (2 off)
C3	4700μ 63V elect.
C4,C6,C10	220n Polyester (3 off)
C5,C7, C11	470n Polyester (3 off)
C8	100n Polyester
C9	1μ Polyester

SEMICONDUCTORS

D1	9V1 Zener 500mW
D2	1N4148
D3,D4,D6	Low current l.e.d. (3 off)
D5	5V6 Zener 5W
REC 1	3A Bridge rectifier (in-line)
TR1,TR2	BC213 (2 off)
IC1	78H05 Voltage regulator
IC2	78L05 Voltage regulator
IC3	7812 Voltage regulator
IC4	LM317L Voltage regulator
IC5	7912 Voltage regulator

MISCELLANEOUS

T1, transformer 18V + 18V secondary 2·78A toroidal; S1, 2-pole mains on/off switch; FS1, 3A 20mm fuse and p.c.b. mounting fuse clips; FS2, 2A 20mm fuse and clips; B1, 9V Ni-Cad PP3 batery and holder; capacitor horizontal mounting clip; TO3 heat sink, 5 deg C/W; P.c.b., PE 864-02 available from the PE P.c.b. Service; high voltage warning label; wire, cable, solder, etc.

EUROCARD MODULE DETAILS

Eurocard module 3U, 20E with fittings
Eurocard module screening kit 3U, 20E
24-way module plug and connector mounting plate

EUROCARD SUB-RACK

Sub-rack 19 inch 3U with fittings
160mm module guides
24-way module socket

It is likely that, at some time, the p.s.u. will be required to supply volatile memory devices whose contents are important. Under these circumstances, it is wise to arrange a back-up supply should the mains fail. In this design, a 5V standby supply is available from a Ni-Cad battery and a low power regulator, IC2.

When power is supplied to the board via T1, the base-emitter junction of TR2 is in reverse bias due to the current through D2 and R5. Under these conditions, B1 cannot supply current to IC2. Should the supply be switched off or inadvertently disconnected, C1 will discharge. When the voltage across C1 falls to approx. 8V, TR2 will conduct and IC2 will provide stand-by current.

CHARGING

A Ni-Cad battery was chosen for back-up as it can be automatically charged when power is supplied to the p.s.u., i.e., in normal use. The maximum constant charge rate for B1 is quoted as 1·1mA. This can be preset via VR1 and checked using a multimeter.

VR1, D1, R2 and TR1 form a constant current source. As current passes through R2 and VR1, the voltage present at the emitter of TR1 will fall. When this falls to around 10V, TR1 will be in reverse bias and the

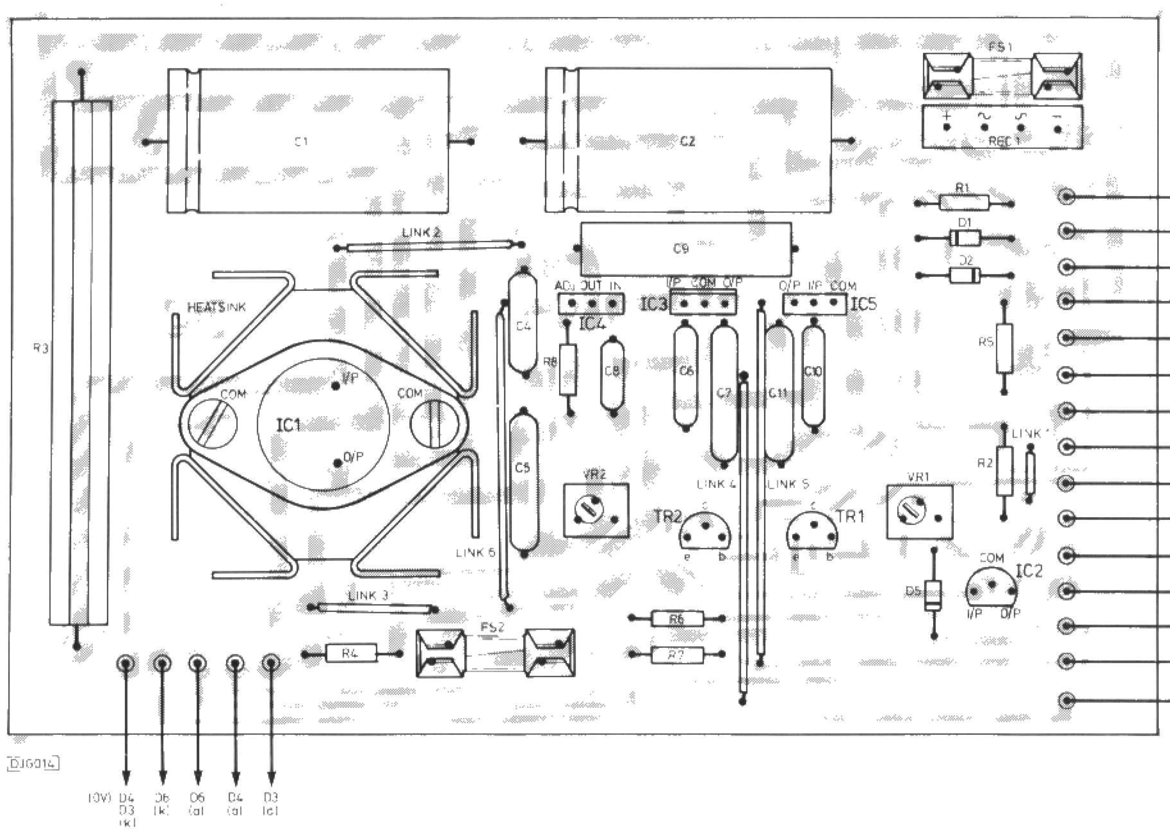


Fig. 2. *P.c.b. design and component overlay*

current through R2 and VR1 will fall. In this way, the current will find a natural level, dependent on the setting of VR1. If battery back-up is not required, simply disconnect B1.

D3, D4 and D6 are low current l.e.d.s which act as supervisory indicators. Under normal conditions, D3 and D6 should be illuminated and under mains failure, D4 should light. If either of the 12V rails fail, D6 will be unlit but D3 should remain illuminated.

CONSTRUCTION

The p.c.b. design and component layout is shown in Fig. 2. Construction and assembly should be fairly simple, but good workmanship is essential if errors and faults are to be avoided. Before mounting any of the components, drill the required holes for IC1. Smaller components such as resistors (not R3) should be mounted first, followed by the transistors, regulators (not IC1) and pre-sets.

The smaller capacitors (non-electrolytic) should be mounted next, followed by C1 to C3 and R3. Lastly, IC1 should be mounted. This component should be carefully positioned (with heat sink compound) together with the heat sink over its mounting holes, making sure that the input and output connections do not touch the heat sink.

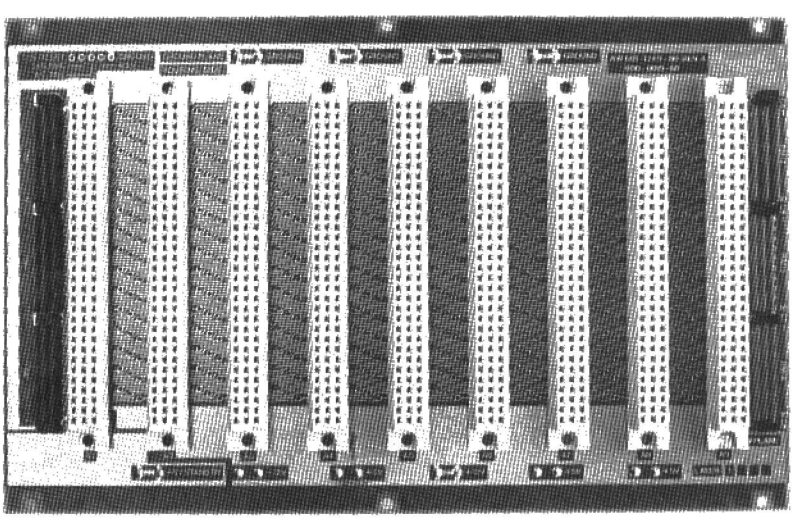


Photo 3. *A typical STEbus backplane*

The i.c. should then be bolted down and soldered in place. Note, that in this design, the case of IC1 is used as a ground connection for D3 and D4 cathodes, so it is essential that metal nuts and bolts are used, making good contact with the p.c.b. tracks.

HOUSING

If the p.s.u. is not being used as part of the PE IEEE P1000 system, or not being module mounted, then the board together with C3, B1, T1 and S1 may be fitted into any suitable case. However, if a Eurocard module is to be used, as it probably is, then mounting details are critical.

NEXT MONTH, this series continues with details of the rack system, STEbus back plane and final constructional details of the p.s.u.

BBC MICRO FORUM

BY RAY STUART

This month, Forum takes a look at the circuitry behind the 1MHz bus

Most computers allow user access to the main address, data and control buses via some form of interface and the BBC microcomputer is no exception. The interface in this case is called the 1MHz bus and provides the user with a powerful yet easily used method of expanding the system. It is this interface that will be discussed in this month's BBC Micro Forum.

1MHz BUS

The 6502 CPU used in the BBC microcomputer is designed to run at 2MHz when accessing its own memory. However, a number of peripheral devices, such as VIAs, will not function correctly at this speed and therefore require a lower clock rate. The BBC microcomputer allows such devices to be used via this bus by adjusting the clock frequency to 1MHz whenever it is accessed; hence the name of the bus.

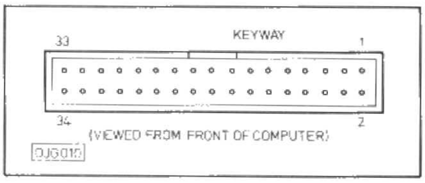


Fig. 1. *IDC connections*

Connection to the bus is by means of a 34-way IDC ribbon cable connector as shown in Fig. 1. Reference to the pin functions in Table 1 shows that the bus consists of eight data lines, eight address lines, seven control lines and an analogue input which allow access to the computer's audio circuit.

At first sight the provision of only eight address lines would appear to somewhat limit the usefulness of the bus by allowing only 256 bytes of memory to be accessed. However, this is far from the truth as it can be used to address an extra 64K bytes of external memory. The mechanism that allows this will be explained later.

CIRCUIT DESCRIPTION

A schematic of the bus circuitry is shown in Fig. 2. The BBC microcomputer's internal address and data bus is buffered before being directed to the output connector. A 74LS244 buffers the eight uni-directional address lines and a 74LS245 buffers the eight bi-directional data lines.

Table 1. *1MHz bus connector pin functions*

PIN	FUNCTION	PIN	FUNCTION
1	GND	18	D_0
2	R/$\overline{W}$	19	D_1
3	GND	20	D_2
4	1MHzE	21	D_3
5	GND	22	D_4
6	NNMI	23	D_5
7	GND	24	D_6
8	NIRQ	25	D_7
9	GND	26	GND
10	NPGFC	27	A_0
11	GND	28	A_1
12	NPGFD	29	A_2
13	GND	30	A_3
14	NRST	31	A_4
15	GND	32	A_5
16	ANALOGUE IN (SOUND)	34	A_6
17	GND	34	A_7

The 6502 generates a R/$\overline{W}$ signal to inform the system if it is reading or writing data. This is also buffered and used to control the data direction input of the 74LS245 before being applied to the 1MHz bus connector. When power is applied to the BBC microcomputer, it generates a reset pulse, called NRST, that is used to synchronize the system. Most peripheral devices connected to the 1MHz bus may also have to be synchronized to the main system, for example when break is pressed, thus this signal is also provided on the 1MHz bus connector.

The 6502 CPU provides two interrupt lines, NNMI and NIRQ. These allow the current operation to be suspended and one of a higher priority to be undertaken. However, the interrupt routines are vectored via addresses stored in the computer's RAM. These are set when the system is initialised or when a ROM is called. Therefore if one wishes to use these interrupts one should do so with care otherwise the system may crash.

The 1MHz bus is allocated two pages in the BBC microcomputer's memory map, pages FC and FD. The main decode circuitry provides two control lines to indicate to the 1MHz bus when it wants to access it. They are designated NPGFC for address range &FC00–&FCFF, and NPGFD for address ranges &FD00–&FDFF. It will be noted that each signal therefore represents a range of 256 bytes. Acorn have chosen to call these address ranges by the two names FRED and JIM, where FRED = NPGFC and JIM = NPGFD.

CLEAN FRED AND JIM SIGNALS

Normally the BBC microcomputer's 6502 CPU runs at 2MHz. However, when the 1MHz bus is addressed, the system changes the clock to 1MHz as stated above. This has the effect of producing "glitches" on the FRED and JIM select lines. It is possible that these glitches could cause the external hardware to believe that data is valid when in fact it is not. Thus spurious data could be transferred across the 1MHz

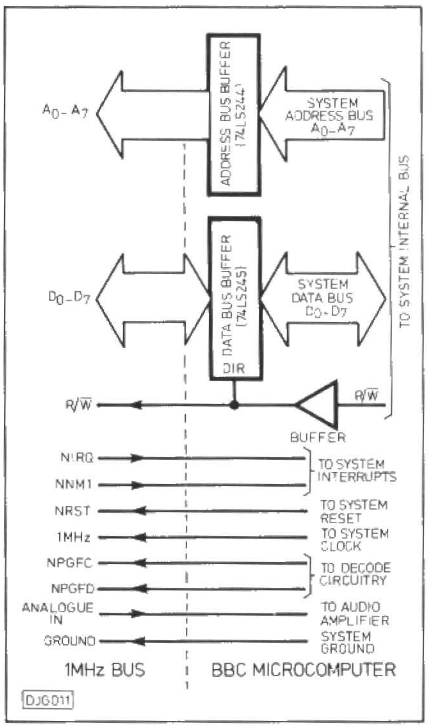


Fig. 2. *Bus circuitry*

Table 2. *Fred memory map (Acorn)*

ADDRESS	ALLOCATION
FC00–FC0F	TEST HARDWARE
FC10–FC13	TELETEXT
FC14–FC1F	PRESTEL
FC20–FC27	IEEE 488
FC30–FC3F	CAMBRIDGE RING
FC80–FC8F	TEST HARDWARE
FCC0–FCFE	USER APPLICATIONS
FCFF	EXTENDED PAGE REGISTER

bus. Obviously this state of affairs cannot be allowed and is easily overcome by using the circuit shown in Fig. 3. This circuit is implemented using a single 74LS02 and although it does not remove every glitch, for most applications, it allows correct operation.

FRED

It is allowable for more than one external unit to be connected to the 1MHz bus at the same time. Should they both occupy the same address range, e.g. &FC00–&FC0F, they would both attempt to send data to the data bus thereby causing it to crash. Acorn have therefore allocated specific areas of FRED for specific applications. These include Acorn's own Teletext, Prestel and IEEE interfaces, and their memory allocations are shown in Table 2.

It will be noticed that this allocation provides the user with only 63 bytes. This may appear to severely limit the usefulness of the 1MHz bus. However, if one considers some of the peripheral interface chips available, then the actual number of input/output lines that can be provided is considerable. Take for example the Intel 8255. This chip provides three 8-bit ports, i.e. 24 input/output lines, yet only requires four memory locations. Thus some fifteen 8255 could be mapped into this area providing some 360 independent input/output lines. This should prove adequate for all but the most ambitious of applications.

If you are designing hardware peripherals for your own use then you are free to use whatever FRED or JIM memory locations you wish. However, if there is any possibility that other 1MHz bus peripherals could be used with the same BBC microcomputer or the peripheral is to be used by someone else, then the memory map specified by Acorn should be adhered to. This will prevent data bus conflicts and consequent system crashes. Once the software and peripheral address decoding has been designed, it is most frustrating to have to redesign it for future applications.

JIM AND THE PAGING REGISTER

The upper memory location in FRED is allocated for what is known as the Paging Register and it is this that allows the bus to address 64K bytes of memory with the aid of a hardware latch. Whenever this latch is addressed it stores whatever data is present on the data bus. If it is arranged for this data to represent the A_8–A_{15} address lines of a 16-bit address then it can be used in conjunction with the A_0–A_7 address lines of JIM to produce a 16-bit address, and hence access 64K bytes of memory. This extra memory is referred to as Extended Page Memory. Acorn have allocated certain address locations for specific applications as indicated in Table 3. Although 32K bytes are allocated for system use by Acorn, there are still 32K bytes available for user applications. Thus the 1MHz bus is far more powerful than first impressions would indicate.

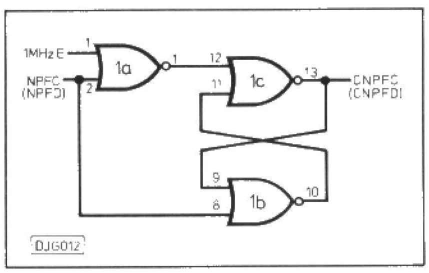


Fig. 3. *Clean-up circuit*

It is a condition of using the paging register that it be set to zero when the BBC microcomputer is switched on or when a keyboard break is issued. A suitable circuit for the paging register latch is shown in Fig. 4.

The 74LS133 is a 13-input NAND gate. Only when all its inputs are Logic 1 will its output be Logic 0. As three inputs are connected to +5V and the other eight inputs connected to FRED's address lines, the 1MHz signal and CNPGFC (via an invertor), the output will only be Logic 0 for address &FCFF. The data bus is applied to the input pins on the 74LS273, an eight bit latch. When the 74LS273's clock (pin 11) is taken to Logic 0 it latches the data present on its input pins. Thus the circuit stores the upper eight address lines of the extended page memory address.

The 74LS273 also has a clear input (pin 1) which when taken to Logic 0

Table 3. *Extended page memory map (Acorn)*

ADDRESS	ALLOCATION
0000-7FFF	SYSTEM
8000-FFFF	USER APPLICATIONS

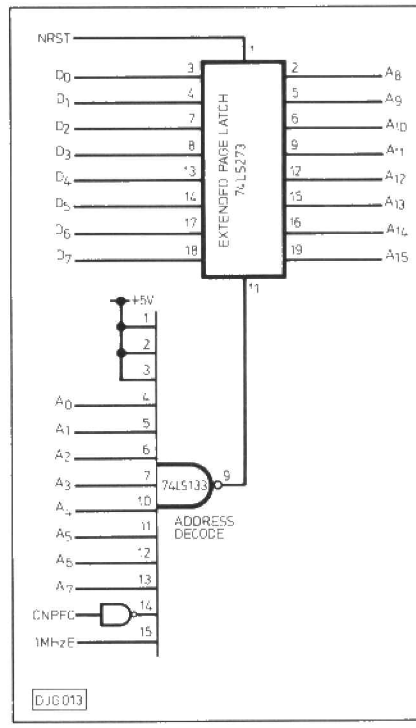


Fig. 4. *Paging register latch*

clears the latches so that the output is zero. The NRST line is therefore connected to this to implement the break condition mentioned above.

HARDWARE CONSIDERATIONS

Acorn have specified certain standards to which hardware connected to the 1MHz bus should conform. These are specified so that correct and reliable operation is ensured and they are discussed below.

The 1MHz bus lines should be loaded with no more than one LS TTL load. In practice this implies that for most peripherals the 1MHz bus should be buffered. Similar circuitry to that inside the BBC microcomputer can be used. A 74LS244 can be used for the address bus buffer and a 74LS245 used to buffer the data bus. The remainder of the signal lines, with the exception of the interrupt and the analogue lines can be buffered using a 74LS04.

All bus lines except NRST, NIRQ, NNMI should be terminated or have the provision to be terminated. The recommended termination is to connect these lines to +5V with a 2k2 resistor and to ground with a 2k2 resistor. The easiest method to achieve this is to use s.i.l. resistor packs.

The recommended method of connecting peripherals to the BBC microcomputer's 1MHz bus connector is via 34-way ribbon cable fitted with 34-way IDC connectors. The peripheral should provide an additional socket to allow further peripherals to be con-

nected to the 1MHz bus. The recommended length is 600mm, but longer cables have been used with some peripherals without loss of performance or reliability. In some cases several metres of cable have been used with no ill effects.

It is recommended that peripherals should be self powered, i.e. fitted with their own mains power supply. However, peripherals have been built that use the BBC microcomputer's own power supply without problems.

SOFTWARE CONSIDERATIONS

Driving the 1MHz bus is relatively easy as it can be regarded as a range of memory addresses and accessed by means of the indirect operator "?". For example data can be written to the 1MHz bus at, say, address &FC09 as follows: ?&FC09 = DATA. In a similar manner, to read the contents of the memory location one could use DATA = ?&FC09.

However the BBC microcomputer's operating system provides four OSBYTEs that are specifically designed to read/write data from/to the 1MHz bus. These are:

OSBYTE &92	read FRED
OSBYTE &93	write FRED
OSBYTE &94	read JIM
OSBYTE &95	write JIM

On entry, X should contain the offset from the start of the page (FRED or JIM), e.g. to read/write to address &FC46 X would contain &46 and the page would be FRED. For a write command, Y should contain the data byte to be written, and for a read operation, Y will contain the data byte read. Note the CALL address for OSBYTE is &FFF4.

Thus one can construct five modules, three procedures and two functions that can be used in programmes. The function command "FN" will always return a result and is therefore used to read from the 1MHz bus. These modules are shown in Program 1.

Program 1. *Simple 1MHz bus operation*

```
 10 REM ********************************************************
 20 REM *                                                      *
 30 REM *              BBC 1MHz Bus interface                  *
 40 REM *                                                      *
 50 REM *           Ray Stuart      January 1985               *
 60 REM *                                                      *
 70 REM ********************************************************
 80
 90
100 DEFPROC_write_fred_(offset%,byte%)
110 X%=offset%:Y%=byte%:A%=&93:CALL &FFF4
120 ENDPROC
130
140
150 DEFPROC_write_jim_(offset%,byte%)
160 X%=offset%:Y%=byte%:A%=&95:CALL&FFF4
170 ENDPROC
180
190
200 DEFPROC_paging_register_(byte%)
210 X%=&FF:Y%=byte%:A%=&93:CALL &FFF4
220 ENDPROC
230
240
250 DEFFN_read_fred_(offset%)
260 LOCAL Z%
270 X%=offset%:A%=&92:Z%=USR(&FFF4)
280 =(Z% AND &FF0000) DIV &10000
290
300
310 DEFFN_read_jim_(offset%)
320 LOCAL Z%
330 X%=offset%:A%=&94:Z%=USR(&FFF4)
340 =(Z% AND &FF0000) DIV &10000
```

First let us consider the write procedures for FRED, JIM and the Paging register. All three procedures are similar and use the same variable names. The variable "offset%" is the lower byte of the address to be accessed and the variable "byte%" is the value to be written to the address. The "offset%" variable is not required for PROC_paging_register as it is fixed at &FF. For example "offset%" would be &56 if the address were &FC56. Note this is sometimes also referred to as FRED &56. Thus to write &34 into address &FC89 (FRED&89) use

PROC_write_fred_(&98,&34)

The two functions are also similar and as with the procedures use the same variables.

The variable "offset%" refers to the lower address byte "Z%" representing the returned value. However, this value is returned as a four byte value with the third most significant byte being the valve we require. The returned value is thus ANDed with &FF0000 to set the unwanted bytes to zero and DIVed by &10000 to produce the required single byte. PE

BOOKS FOR THE BBC

BEGINNERS GUIDE TO INTERFACING THE BBC MICROCOMPUTER
Martin Philips—Macmillan. ISBN 0-333-38652-3 170 pages paperback. £6.95

As the title suggests, this book is for beginners. Some prior knowledge of programming is required but only a basic understanding of physics is needed to get to grips with the electronics.

The first few chapters introduce simple electronic principles and familiarise the reader with the BBC user and digital ports. Following chapters deal with various home interface projects, each one described in detail and backed by substantial software listings.

A useful appendix section is included which contains three fully explained programs for: calculating values, interpreting resistor colour codes and designing the user port.

R.M.B.

THE TRANSDUCER PROJECT BOOK
Michael J. Andrews—Tab Books Inc. ISBN 0-8306-1992-5 130 pages paperback. £7.95

The Transducer Project Book is suited to the beginner. There is a minimal amount of electronics involved with each project but the principles which are used, are fully explained at each stage.

Transducers, nowadays, are often associated with computers. Most of the projects in this book can be built and used without the need for computer interfacing or indeed a computer. Only a small section is devoted to computer applications.

Projects described include: digital yardstick, sound activated switch, electronic balance, frequency meter and a temperature controlled crystal oven.

F.R.S.

BYTEBOX UPDATE

Modifications and further design ideas for the Bytebox

The Bytebox project published in October–November 1985 is probably the most popular of recent PE projects. It has stimulated a great deal of response from readers who intend to, or have built it—most with success. From this response, we have learnt of a few modifications which may be of further interest to Bytebox owners.

UPDATE ONE

By J. R. KELLY

In successfully completing the Bytebox I experienced a few problems which I thought should be brought to your attention.

1. The EPROM circuit board (009) needs a shorting link between pins 27 and 28 on IC 302 to conform with the circuit diagram. Otherwise the computer will not necessarily access the lower 8K of the ROM.

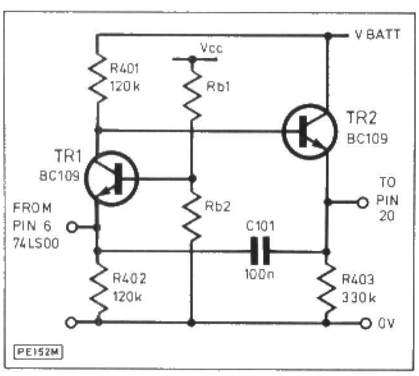


Fig. 1. *Using positive feedback*

2. The battery backed RAM circuit does not always work effectively. At least mine did not.

The frequency response of the BC 109 is quoted in the catalogues as 300MHz in common base mode. In common emitter, as in the published circuit, the frequency response is roughly this figure divided by the current gain, which with a low gain device gives about 2MHz at best. The transistors in the circuit are expected to pass pulses of one half microsecond width, but since they are connected in common emitter without feedback this is not possible. Inspection with an oscilloscope confirmed this. The pulses were present at pin 6 of the 74LS00 but were not getting through the transistors. By putting speedup capacitors across R203 and R205 a rudimentary pulse appeared but nothing like good enough to operate the system. The circuit of Fig. 1, using a common base input stage followed by an emitter follower output with overall a.c. positive feedback, works very well.

With the computer switched off, TR1 is unbiased and not conducting and TR2 adds about 10 microamps to the battery drain. From Mr Stuart's figures this should give a battery life of 80 days instead of 100 days.

In the course of developing this circuit I had redesigned the battery charging circuit and, to reduce biasing problems, used it to run the 74LS00 from the battery voltage. The complete circuit is shown in Fig. 2 complete with the new components.

As the battery voltage falls, the bias voltage on TR3 increases and more charging current is supplied. The diode can be any small signal general purpose silicon type and the transistors used were plastic BC 107s although almost any small signal type would do.

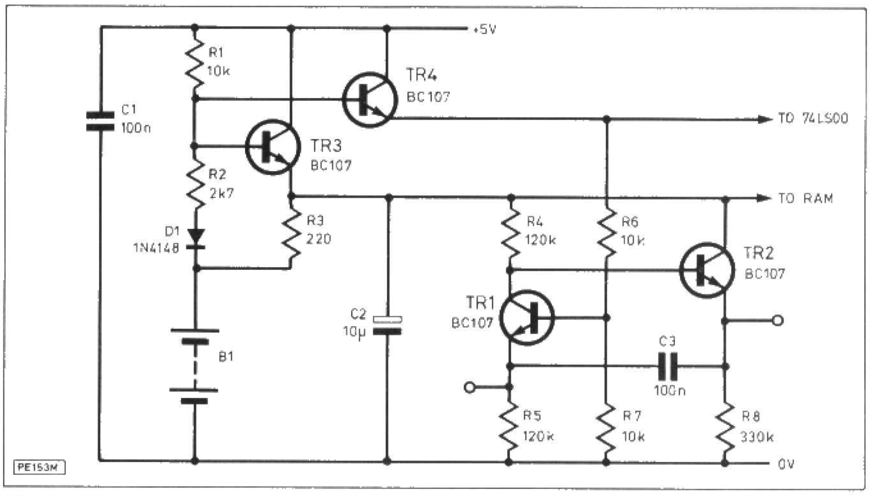


Fig. 2. *Battery charging circuit changes*

The bias for TR1 must be low impedance since it is in common base mode but if a decoupling capacitor is used in the conventional fashion then a time delay is introduced and the first few bytes from &8000 do not get programmed. By keeping the bias purely resistive this problem was overcome, which is why the bias resistors are lower than normal.

If the original charging circuit is used then Rb1 should be 18K and Rb2 10k. The whole circuit is on a piece of

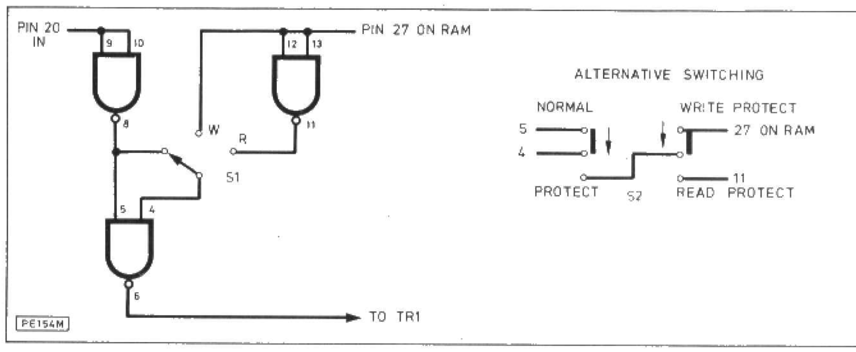


Fig. 3. *Read protect facility using rehashed logic*

Veroboard 1·5 by 0·8 inches supported at the side of the original board by its connecting wires.
3. By rehashing the logic I have provided a read protect facility as well as a write protect with only three of the gates in the 74LS00.

Pin 27 is controlled by the R/W output of the 6502 and is at logic 0 for a write and logic 1 for a read operation. A logic 0 on pin 4 will force a logic 1 on pin 6, deselecting the RAM. By inverting the read signal and applying it to pin 4 the chip is deselected during a read operation but can still be written to, thus enabling you to regain keyboard control and flush out the RAM after what might have otherwise been a catastrophic crash.

UPDATE TWO

By RAY STUART

I do not agree with all of Mr Kelly's comments. The prototype battery backed RAM board did work. I have, however, heard that some people have experienced problems. Whilst I think that Mr. Kelly's circuit will work (I have not tried it myself), I would like to offer my solution which is even simpler than the original circuit. This is shown in Fig. 4.

Mr. Kelly's modification to the write protect circuit is amusing, but I cannot think why one might want a read protected RAM, unless it's his vision of a black hole!

There is another simple addition that has proved useful to me which I think will be of interest to others. When developing some software to run from sideways ROM, it is useful to test it in sideway RAM before committing it to ROM. Should one get the software wrong and effectively put rubbish into the RAM the system can see this as commands, and crash. Once this happens it is impossible to clear by switching off as it is battery backed. The only way of clearing the rubbish is to remove the card. Obviously this is annoying. The addition I suggest is to fit a second switch to allow the battery to be disconnected and the RAM to be powered by the BBC's +5V line directly. This addition is detailed in Fig. 4. PE

Constructors' Note
A complete kit of parts for the Bytebox is available from: Peripheral Projects, 25 Braycourt Ave, Walton-on-Thames, Surrey.

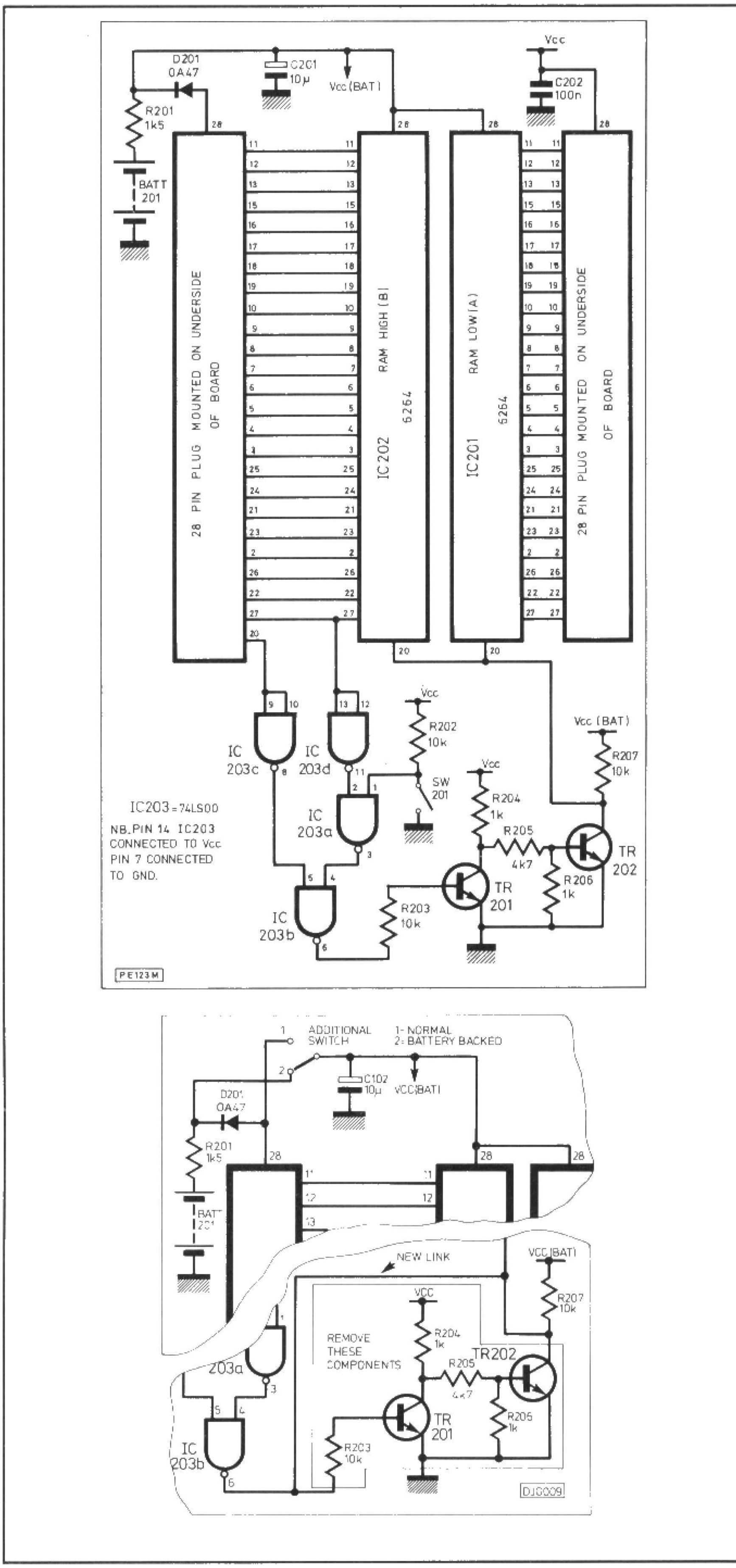


Fig. 4. *Author's solution and original circuit*

TEMPERATURE-ANALOGUE INTERFACE

BY R. A. PENFOLD

Two-channel temperature interface plus dual analogue ports for the Amstrad and the Spectrum

THIS interface was designed to give the Amstrad CPC464 computer four analogue inputs, two of which are intended for use with semiconductor temperature sensors to give a measuring range of 0 to 51 degrees Centigrade with 0·2 degree resolution. However, the unit can be used as a straightforward four channel analogue to digital converter if desired.

Although the unit was not designed with the Spectrum computer in mind, it has been tried with this computer and worked perfectly well. The only modification required for use with the Spectrum is the use of a different edge connector.

The two analogue inputs have a full scale sensitivity of 1·2V and can be used together to provide a single differential input. If the inputs for the two temperature sensors are used as ordinary analogue inputs they have a full scale value which is adjustable from about 350mV to 1·2V. The sensitivity of each channel is individually adjustable. All four channels offer an accuracy of plus and minus 1 l.s.b.

SYSTEM OPERATION

A circuit of this type could be quite complex, but in this case things are kept remarkably simple by using a modern four-channel analogue to digital converter chip (the ADC0844CCN) and an equally modern temperature sensor chip (the LM35DZ). Fig. 1 shows the block diagram for the interface, and several of these blocks represent the internal circuit of the ADC0844CCN.

At the heart of the unit is the single successive approximation converter of the ADC0844CCN. The way in which this type of converter functions has been described in previous articles in this magazine, and we will not consider this aspect of the unit in detail here. While not providing ultra-fast conversions, the successive approximation technique is reasonably fast and can be achieved by a relatively low cost device. In the case of the ADC0844CCN the conversion time is no more than 40μs, and at 25 degrees Centigrade is typically 30μs. This enables up to about 25000 conversions per second to be achieved, which is more than adequate for the vast majority of applications. The reason for the exact conversion time being temperature dependent is that the ADC0844CCN has a built in clock oscillator which includes on chip timing components. The lack of frequency stability that this inevitably produces is of little practical importance, and it helps to minimise the number of discrete components that are needed.

A four-channel analogue multiplexer ahead of the converter provides the unit with its four input channels. This is not as good as having four separate converters as each channel in use has to be read in turn. With all four channels in use this enables each channel to be read only about 6000 times or so per second, but even this reduced rate is far higher than is required for most applications.

The required channel is selected by writing data to the converter, but only the four least significant bits are utilized when doing this. The data is stored in a four-bit latch, and in addition to selecting the channel to be converted it also sets the operating mode of the device and initiates a conversion. There are three operating modes, and these are single ended, differential, and pseudo differential. The single ended mode is the normal one where each input responds to the input voltage relative to the earth rail. In the differential mode the converter becomes a two-channel type with one pair of input voltages applied to chan-

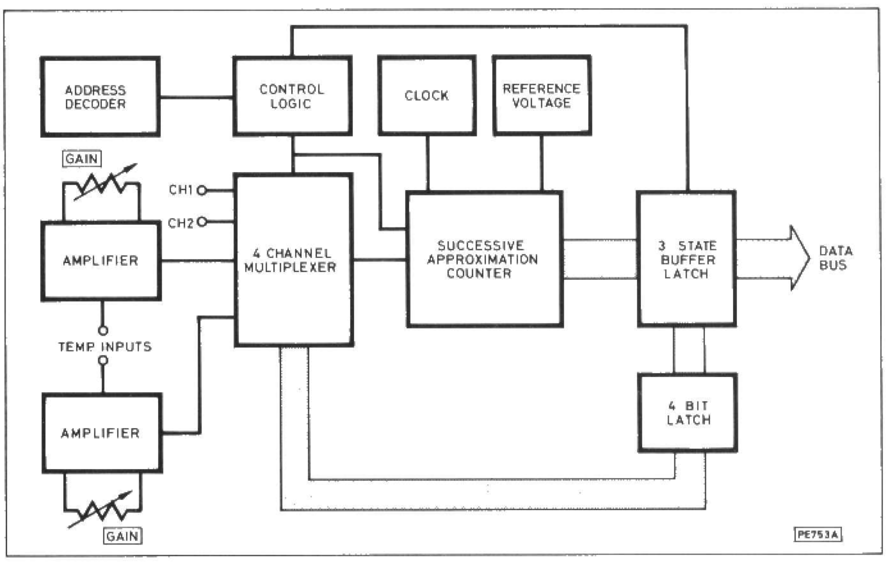


Fig. 1. *Block diagram*

Unlike many analogue to digital converter chips, the ADC0844CCN does not include an internal reference voltage source. The full scale value of the converter is equal to the reference voltage used, and this can be any voltage of 5V or less. In the interest of good linearity it is not advisable to use a reference potential of much less than about 1V though. In this circuit a highly stable 1·2V reference source is utilized.

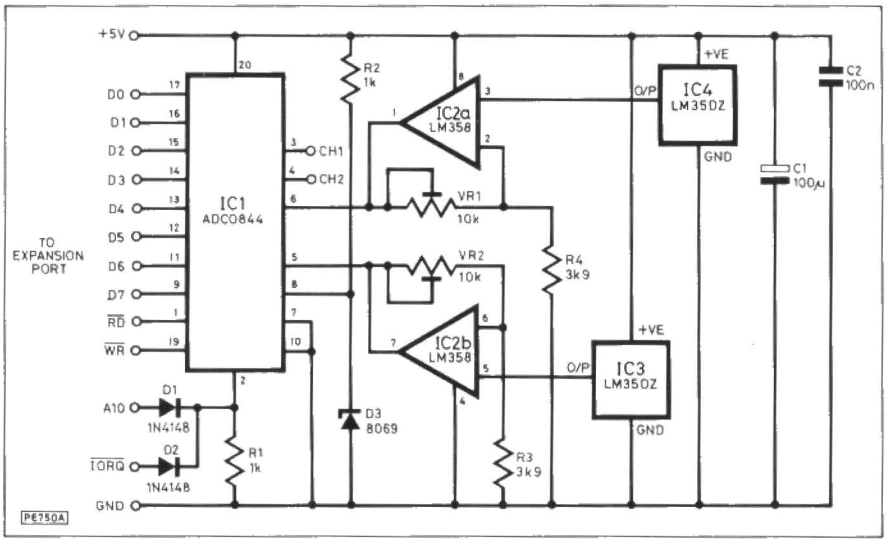


Fig. 2. *Complete circuit diagram*

nels 1 and 2, and the other two applied to channels 3 and 4. In the pseudo differential mode the unit is reduced to three channels (1, 2, and 3) with channel 4 being used as the inverting input for all three channels. This mode is not really applicable in this case due to the amplifiers added ahead of the channel 3 and channel 4 inputs.

When a conversion has been completed the result is stored in an eight-bit data latch which has three state outputs. The outputs of the latch can therefore be connected direct to the data bus of the computer. Although the converter has four channels it only occupies one address, and the channel read at that address is the one previously selected by a write operation. Even if the same channel is read each time, a write operation must precede the taking of each reading in order to initiate fresh conversions. Otherwise the same conversion would be read repeatedly.

The address decoder is extremely simple, and only decodes one address line plus one control line. This is made possible by the simple system of input/output mapping used in the CPC464 and Spectrum computers, plus the fact that the ADC0844CCN is specifically intended to interface with 8080/Z80 based systems, and has inputs for the RD (read) and WR (write) lines.

TEMPERATURE SENSOR

There are normally difficulties if a semiconductor temperature sensor is connected direct to the input of an analogue to digital converter without using some form of signal conditioning circuit. For example, the popular LM335Z provides an output of 10mV per degree Kelvin, or 2·73V plus 10mV per degree Centigrade in other words. A temperature range of (say) 0 to 50 degrees Centigrade therefore gives an output voltage range of 2·73V to 3·23V. Obviously the output of the sensor could be fed to an analogue input having a full scale value of 3·23V, but this would be a very inefficient way of doing things since input voltages from 0V to 2·73V would never occur, and most of the converter's input range would be wasted. This is not merely of academic importance, and in practice would result in the system having relatively poor resolution and accuracy.

Much better results could be obtained using a signal conditioning circuit to remove the 2·73V offset, and to spread out the 0 to 50 degree range over the full input voltage range of the converter. This type of manipulation is rendered unnecessary by the LM35DZ temperature sensors used in this design. These have a built-in circuit to eliminate the offset voltage, so that the output voltage is nominally 10mV per degree Centigrade. This gives a 0 to 510mV output voltage range over the 0 to 51 degrees Centigrade temperature span covered in this case. A simple d.c. amplifier at each of the two temperature sensor inputs boosts this to a 0 to 1·2V range which fully drives the converter. The converter provides readings of 0 to 255, which conveniently converts to readings in degrees Centigrade simply by dividing returned values by five. The gain of both amplifiers has been made variable so that they can be set up for optimum accuracy.

It must be pointed out that at very low temperatures of only about 1 degree Centigrade the LM35DZ may not give good accuracy, but it will give good results over a range of 2 to 51 degrees Centigrade. In its favour it has the advantage of not requiring a highly stable supply, or even a stabilised supply for that matter, and it will operate over a 4 to 30 volt supply range. With a current consumption of only 56µA there is little self heating.

CIRCUIT OPERATION

The full circuit diagram of the interface appears in Fig. 2. D3 and R2 form a shunt regulator which provides the 1·2V reference for converter chip IC1. D3 is not an ordinary Zener diode, but is a highly accurate and temperature compensated regulator chip. IC2 provides the two amplifiers which are conventional operational amplifier non-inverting mode types. The LM358 is one of the few operational amplifiers that is capable of providing output voltages right down to the earth rail, and this renders a negative supply rail unnecessary. IC3 and IC4 are the two LM35DZ temperature sensors.

The unit connects to the floppy disc port of the CPC464 computer, which is really a general purpose expansion port having the full buses etc. available. The system of input/output mapping used in the CPC464 is to have circuits activated by taking one the eight most significant address lines low. One or more of the eight least significant address lines can be decoded as well if an input/output circuit requires several addresses (which is obviously not the case here). Address line A10 is available for external add-ons, and this line is decoded with the IORQ (input/output request) line and used to generate the negative chip select pulse for IC1. D1, D2, and R1 form a simple 2-input OR gate. The interface is placed at address &F800 in the

COMPONENTS . . .

RESISTORS

R1,R2	1k (2 off)
R3,R4	3k9 (2 off)

All ¼W 5% carbon

POTENTIOMETERS

VR1,VR2	10k 0·1W horizontal preset (2 off)

CAPACITORS

C1	100µ 10V radial elect
C2	100n ceramic

SEMICONDUCTORS

D1,D2	1N4148 (2 off)
D3	8069
IC1	ADC0844CCN
IC2	LM358
IC3,IC4	LM35DZ (2 off)

MISCELLANEOUS

Case about 133 by 70 by 38mm; printed circuit board, PE 101; computer connector; 20 pin d.i.l. i.c. holder; 8-pin d.i.l. i.c. holder; stereo jack socket (3 off); stereo jack plug (3 off); 14-way ribbon cable; connecting wire; solder, etc.

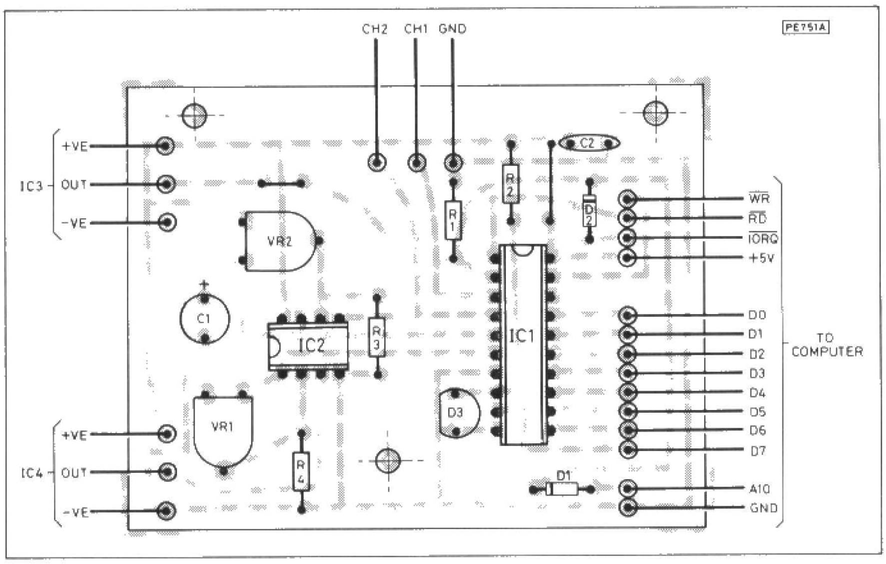


Fig. 3. *P.c.b. design and component layout*

input/output map. Of course, as there is only partial address decoding the circuit can be activated using a large block of addresses, but the one mentioned above is the base address and is a convenient one to use in practice.

In essence the system of input/output mapping adopted for the Spectrum is the same as that used in the CPC464. There is a slight difference in that one of the lower eight address lines is taken low to activate input/output circuits, and one or more of the upper eight address lines are used if additional addresses are required. For the Spectrum it is address line A5 that is gated with the $\overline{\text{IORQ}}$ line, and address 65503 that the circuit occupies. Again, due to the partial address decoding the circuit occupies a great many addresses, but in practice 65503 is probably the best one to use.

POWER SUPPLY

The circuit requires a single (+5V) supply. The current consumption is only a few milliamps, and both the CPC464 and the Spectrum can readily supply this.

CONSTRUCTION

Fig. 3 shows the printed circuit board design for this interface. An important point to note is that IC1 is a CMOS device and should accordingly be fitted in a (20 pin d.i.l.) i.c. holder.

The other standard antistatic handling precautions should also be observed. There are two link wires which should not be overlooked, but in other respects construction of the board is quite ordinary.

The exact form that mechanical construction of the unit takes will depend on how it is to be used. It can simply be left as a loose board or, like the prototype, it can be built into a case. A third alternative is to incorporate the unit in to some larger piece of equipment. Whatever method is used the printed circuit design of Fig. 3 should be satisfactory.

Assuming that the unit is to be built into its own case, an aluminium box having approximate outside dimensions of 133 by 70 by 38mm is suitable. The temperature sensors would not normally be mounted on the printed circuit board, but would be remotely located and connected to the interface by way of three-way cable. In order to minimise problems with stray pick up of noise it is advisable to use twin overall screened cable, with the screen carrying the negative supply rail connection. On the prototype three stereo

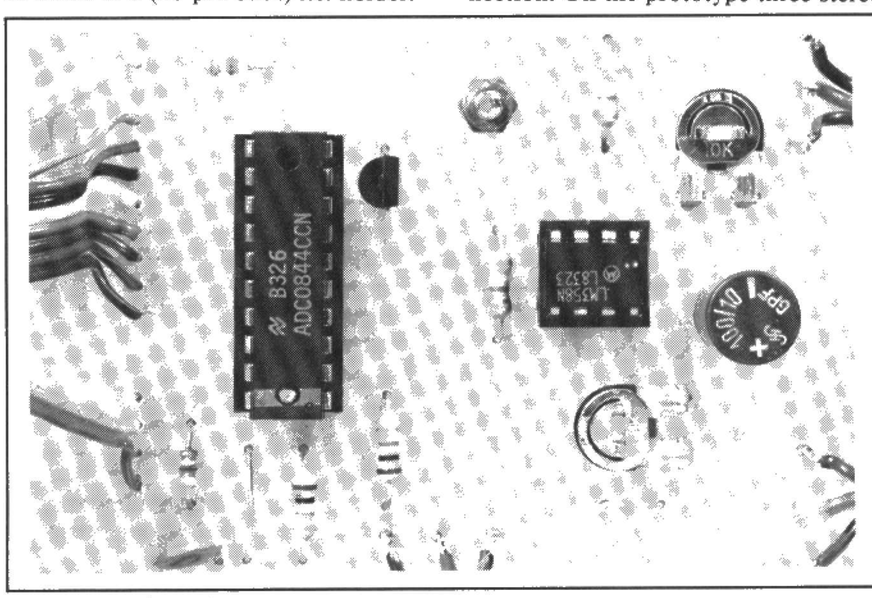


Photo 1. *P.c.b. and component mounting details*

jack sockets are mounted on the front panel, and connections from the sensors to the printed circuit board are made via two of these. The third one is used for the two ordinary analogue inputs.

A 14-way ribbon cable up to about one metre long connects the printed circuit board to the floppy disc port of the CPC464 or the expansion port of the Spectrum. For the Amstrad computer a 2 by 25-way 0·1 inch pitch edge connector is required. As it is unlikely that a connector having a suitable polarising key will be available care must be taken to fit the connector the right way up, and it is advisable to clearly mark the top edge. The Spec-

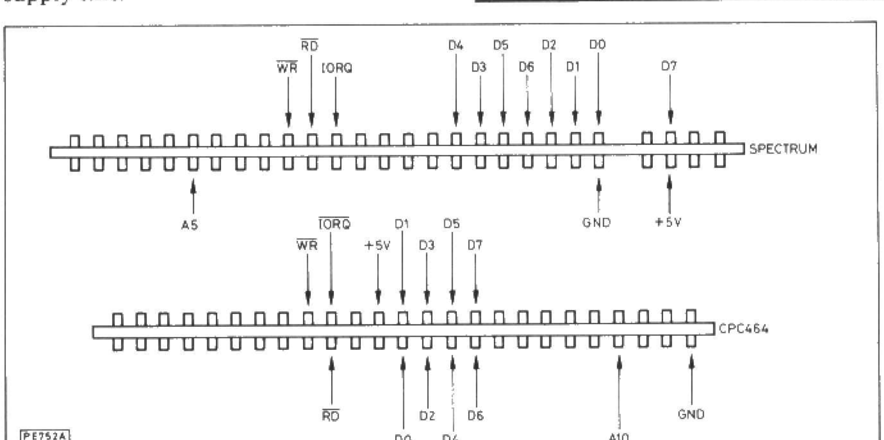


Fig. 4. *Computer connection details*

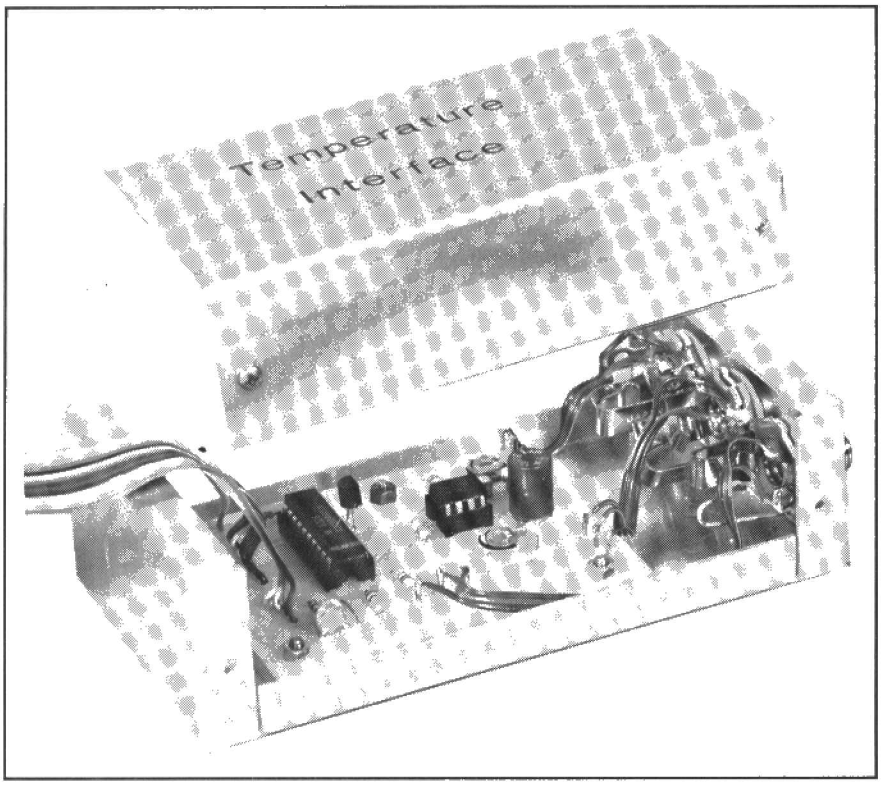


Photo 2. *Constructional details of the Temperature Interface*

Table 1. *Amstrad listing*

```
10 REM CPC464
20 MODE 0
30 LOCATE 8,5
40 PRINT "DEGREES C."
50 OUT &F800,6
60 LOCATE 5,10
70 PRINT (INP(&F800))/5
80 OUT &F800,7
90 LOCATE 15,10
100 PRINT (INP(&F800))/5
110 FOR D = 1 TO 1000:NEXT
120 LOCATE 5,10
130 PRINT "      "
140 LOCATE 15,10
150 PRINT "      "
160 GOTO 50

10 REM SPECTRUM
20 PRINT AT 8,10;"DEGREES C."
30 OUT 65503,6
40 PRINT AT 16,7;IN 65503/5
50 OUT 65503,7
60 PRINT AT 16,20;IN 65503/5
70 PAUSE 50
80 PRINT AT 16,7;"      "
90 PRINT AT 16,20;"      "
100 GO TO 30
```

trum's expansion port requires a 2 by 28-way 0·1 inch pitch edge connector, and types having a suitable polarising key are readily available. Fig. 4 gives connection details for both computers.

Take great care not to make any wiring errors, and thoroughly check all the wiring once it has been completed. With the specified case it is possible to take the ribbon cable out between the top and base sections, but if an alternative is used it might be necessary to cut an exit slot in the rear panel.

TESTING AND USE

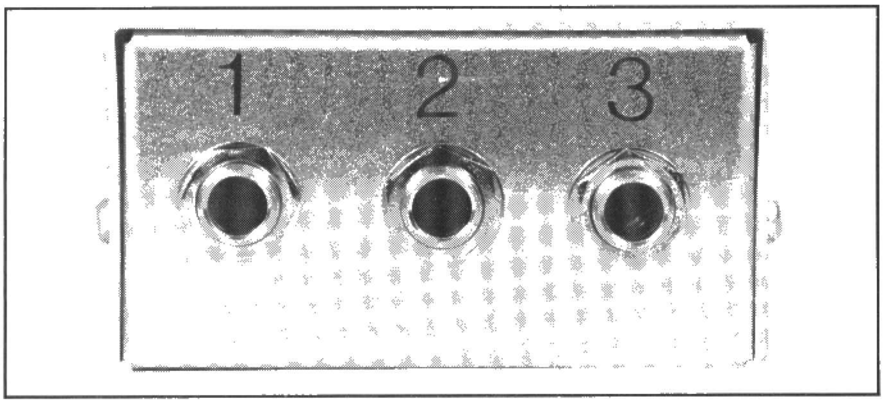
Start with VR1 and VR2 set at about half maximum resistance. Connect the interface to the computer before switching on the computer. The two simple programs shown in Table 1 can be used to give a temperature readout in degrees Centigrade for both temperature channels.

From BASIC, the OUT instruction is used to write the appropriate number to the converter to start a conversion and select the required channel. The number is 6 to read IC4 and 7 to read IC3. The INP function (IN for the Spectrum) is used to read the converter, and as explained earlier, dividing the reading by five gives a reading in degrees Centigrade. The relative slowness of BASIC means that a conversion will always have been completed by the time the unit is read, but when using machine code a delay loop to provide a hold off of at least 40µs will be required.

In order to calibrate the unit both sensors should be taken to a known temperature, and one that represents about 50% to 100% of the full scale value. The two presets are then adjusted to give the correct reading. If the sensors are to be used in liquids they should be fitted in a small test tube or a similar container to protect them. Some silicon grease can be used to give a good thermal contact between each sensor and its container.

In the single ended mode analogue channels 1 and 2 are selected using values of 4 and 5 respectively. When these are used as a single differential input they are selected using values of 0 (channel 2 is the inverting input) or 1 (channel 1 is the inverting input). PE

Photo 3. *Front panel details*



PHOTOGRAPHIC TRIGGER UNIT

BY R. E. HEAD

Sound or light triggered unit which has applications in photography and security

Many photographic trigger units are dedicated to one function; this design is different. It allows a camera to be triggered as an object passes through an invisible narrow beam. The object could be fairly large, such as a fox, or as small as a butterfly. Additionally, the main trigger unit can be switched to respond to noise, allowing, for instance, an effective photograph of a light bulb smashing on impact. The sensitivity of this section of the circuitry is pre-settable.

A block diagram of the system is shown in Fig. 1. Both beam trigger and sound trigger impulses are fed through a selector switch allowing positive or negative operation. In other words, with the switch in one position the photograph is taken when the beam is switched on, or sound occurs. The other switch position causes the photograph to be taken when the beam is broken. Two variable delay circuits are incorporated. The first "trigger" delay controls the time between the beam being broken, or sound occurring, and the photograph being taken. This is variable up to four seconds. The purpose of this delay is to allow framing of a slow moving object, whilst the second delay controls the output pulse width, to control the number of photographs the camera takes. This delay has a control range of 0.5 to 5 seconds.

The units were principally designed to drive a camera motor-wind, which conveniently has a 2·5mm socket to permit the camera to be remotely triggered. For those without such luxuries, two other methods of photography are possible, the first involves using a flash triggered from the beam unit, leaving the camera lens open. This is the fastest possible arrangement but, of course, has to be done in the dark. The final method of taking the picture involves using a solenoid to operate a "Bowden" cable type camera release. This, however, involves constructing some sort of mechanical device, since I have been unable to locate a manufacturer of such an item.

The beam trigger set-up could be used in security systems, either to take a picture or, making use of the output switch, to operate an alarm bell.

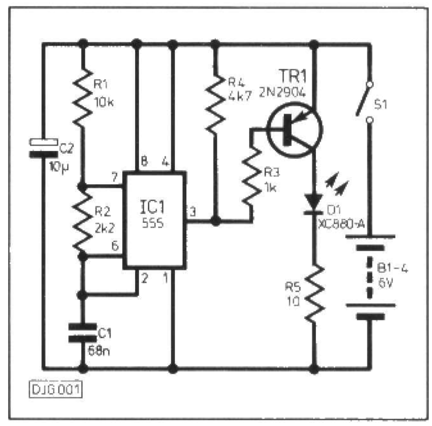


Fig. 2. *Transmitter circuit diagram*

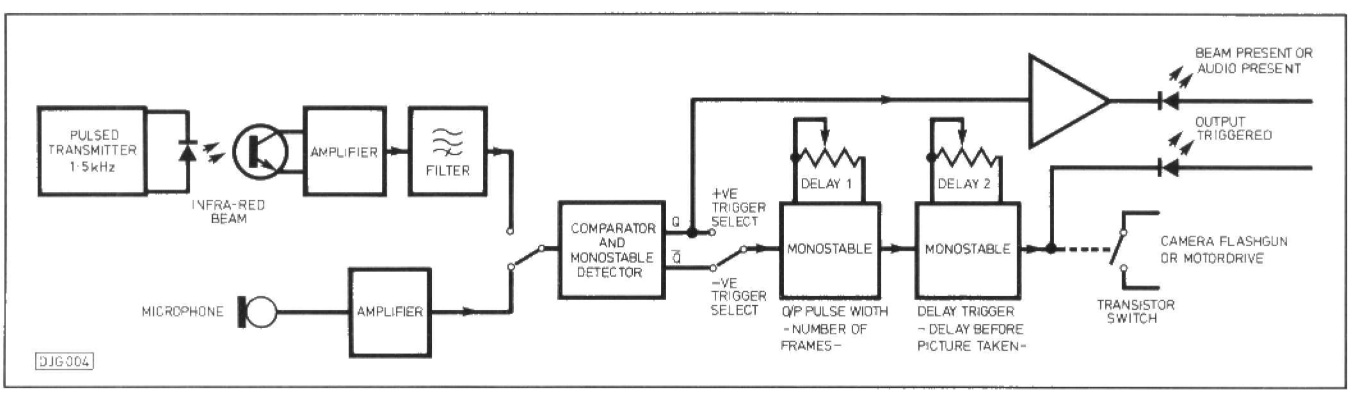


Fig. 1. *Block diagram of the complete system*

BEAM TRANSMITTER

The transmitter unit, Fig 2, is based around an XC-880-A infra-red (IR) light emitting diode. To allow both high output, with a fair range, and low battery consumption, the diode is pulsed at a ratio of 5:1. An oscillator, an NE555 timer connected as an astable, running at approximately 1500Hz, switches the output to turn on TR1 for 130μs, and off for 530μs. R1 and R2 in conjunction with C1 determine frequency and pulse width.

Output transistor, TR1, is driven by R3 and switches on the output diode via a current limiting resistor R5. The average power consumption at 6V is 40mA, which should give approximately two hours operation from four AA type batteries.

BEAM RECEIVER

The beam receiver unit, Fig. 3, is based around a quad op-amp and detects the pulsed beam using an IR photo-sensitive transistor TR1, type

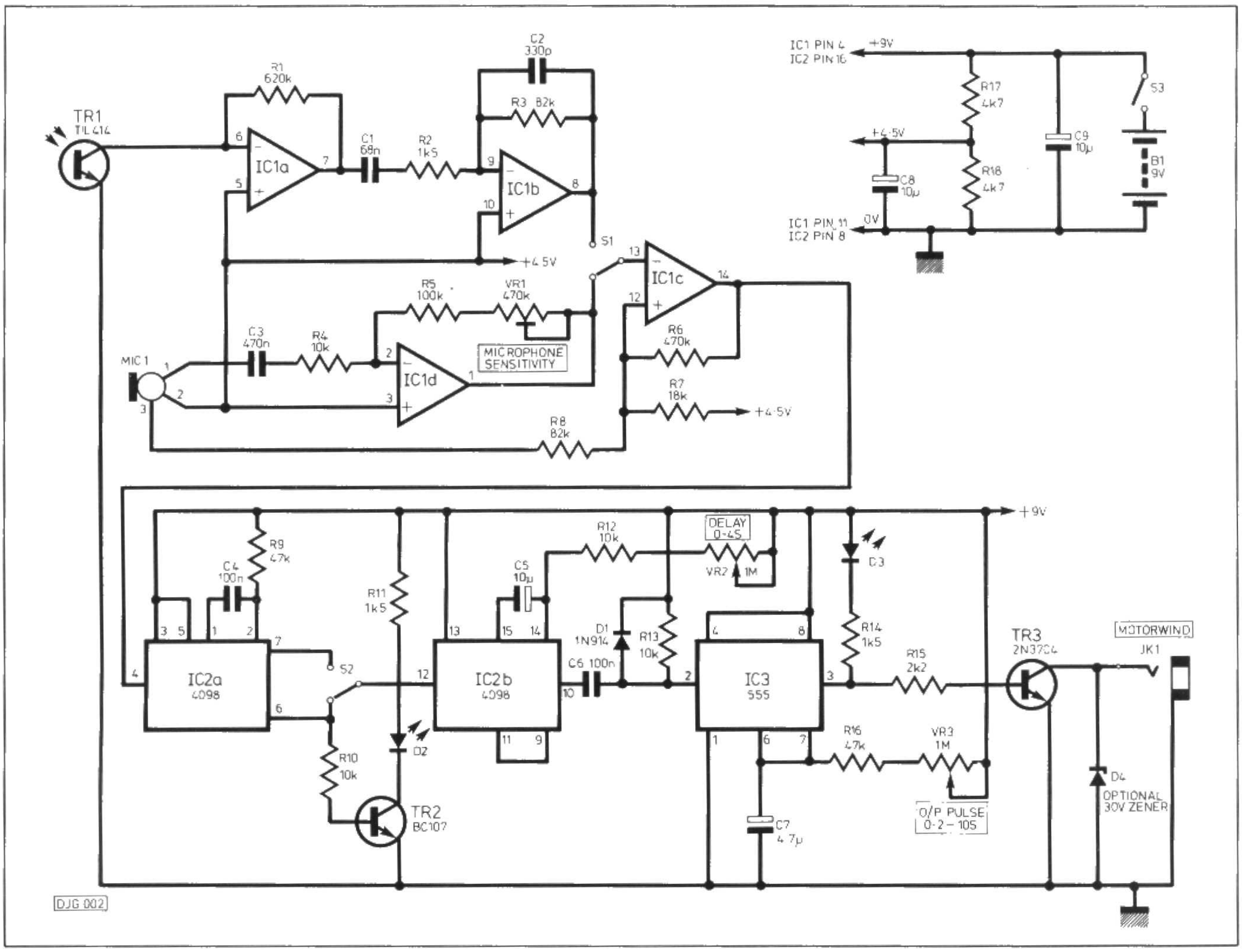


Fig. 3. *Complete circuit diagram of the receiver unit*

TIL414. This is amplified by the first stage op-amp, with the gain set by R1. This stage produces an output of 100mV pk-pk at a range of about 1·5 metres, dependent on ambient light. The second op-amp forms a high-pass amplifier, to reduce the effects of mains lighting pick-up. This stage has a gain of 30 at 1500Hz and approximately unity gain at 50Hz. From this stage the signal is fed to a change-over switch input. The other input to the change-over switch is connected to the output of the third op-amp stage. This amplifies the output from a capacitor microphone insert mounted on the front of the case. The stage gain is controlled by R5 and VR1, a preset potentiometer, and ranges from ×10 to ×100.

The switch selected output is connected to a schmitt trigger, formed by the last op-amp stage, with positive feedback, set to trigger at 3·5V. The output from this stage is connected to the first half of IC2, an MC4098B, wired as a re-triggerable monostable. This has a time constant (TC) of 2ms, controlled by R9 and C4. When the IR amplifier is detecting a series of pulses from the transmitter the output of the monostable remains high (logic one). This then forms the detector stage, driving a light-emitting diode indicator to show a beam is present and correctly aligned, or that sound is present. Both outputs (Q & –Q) from this stage are connected to a change-over switch S2. This allows for the positive or negative modes of operation as mentioned previously. The output from this switch is connected to the positive trigger input of the second half of IC2 arranged as a non-retriggerable monostable with a variable time constant controlled by R12, VR2 and C5. The time constant is variable from 20ms to 4s. The output from this i.c. is differentiated by C6, in conjunction with D1 and R13, the resultant pulse is used to trigger the NE555, IC3.

The output of IC3 drives an l.e.d. to indicate an output pulse. It should be noted that the diode extinguishes to indicate a trigger; and thus acts as a power-on indicator.

Also IC3 drives the output switching transistor, TR3, an n.p.n. switching transistor. This will drive most motor-winds, and some flash-guns. It is important to note that the unit will only drive either of these units, not both together. The type of flash-gun used with the output transistor specified was an Olympus T20; this has only about 2·5V across its contacts, other cheaper models can have up to 300V across their contacts. If possible, check with a high impedance voltmeter the contact voltage before use. (The maximum is around 30V.)

IC3 has a time constant variable between 0·5 to 5s. This corresponds to between 1 and 12 frames when using a 2·5 f.p.s. motor-wind. The time con-

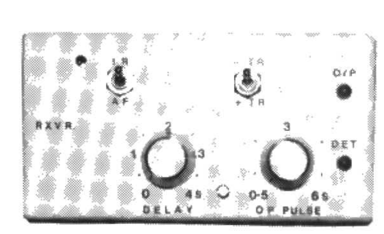


Photo 1. *Receiver front panel*

stant is controlled by C7, R16 and VR3. When used with a flash-gun, the output pulse width control will not function in the same way, in fact, if a fast charge flash-gun is used, it may fire twice if VR3 is set to maximum, and therefore VR3 should be left at minimum.

R17 and R18 form a potential divider across the battery, giving a voltage on the non-inverting inputs of the op-amps of 4·5V. The completed receiver unit runs happily on a PP3 type battery for several hours.

The type of microphone specified for this project is a cheap capacitor insert measuring approx. 9·5mm dia. by 6mm. These microphone inserts require 1·5V, however the prototype ran from 4·5V perfectly satisfactorily.

CONSTRUCTION

Both units are designed to be fairly uncritical in layout, and can be built easily on strip board. However, to produce neat, small, units the prototypes employed two printed boards which allow the units to fit inside small cases.

TRANSMITTER

The p.c.b. design for the transmitter is shown in Fig. 4. Firstly, cut a 30mm length of copper tube. This is anchored to the board by two short lengths of wire, passing through four 1mm holes drilled either side of the tube, and soldered to track on the board. Fit the l.e.d. to the board, such that the body of the l.e.d. inserts into the tube, and bend the wires to fit onto the track. The polarity of this diode is important.

Finally, fit the remaining components, and the i.c. to the board. The battery connector leads should be threaded through the board to provide a reliable anchoring. The on/off switch is wired to the board by two short (65mm) lengths of wire.

When drilling the plastic case, ensure that the fixing holes on the board line up with the mouldings on the base of the box, these are asymmetric to catch out the unwary. The board can be fitted to the case with four 6BA screws. To retain the battery pack in place, two short lengths of self adhesive foam, i.e. draught excluder, should be fitted to the lid of the box.

COMPONENTS . . .

BEAM TRANSMITTER

RESISTORS

R1	10k
R2	2k2
R3	1k2
R4	4k7
R5	10

All $\frac{1}{8}$W unless stated otherwise

CAPACITORS

C1	68n 6V min. ceramic
C2	10µ 12V min. electrolytic

SEMICONDUCTORS

D1	XC 880–A
TR1	2N2904A
IC1	NE555

MISCELLANEOUS

S1 Miniature toggle switch s.p.s.t.; battery holder to accept 4 × AA cells; battery clip for above with flying leads; wire; solder; p.c.b., PE 103, etc.

RECEIVER UNIT

RESISTORS

R1	620k
R2,R11, R14	1k5 (3 off)
R3,R8	82k (2 off)
R4,R10, R13	10k (3 off)
R5	100k
R6	470k
R7	18k
R9,R16	47k (2 off)
R15	2k2
R17,R18	4k7 (2 off)

All $\frac{1}{8}$W

CAPACITORS

C1	68n min. ceramic
C2	330p polystyrene
C3	470n min. ceramic
C4,C6	100n min. ceramic (2 off)
C5	10µ 16V tantalum
C7	4µ7 16V tantalum
C8,C9	10µ 12V min. electrolytic (2 off)

SEMICONDUCTORS

D1	IN4148
D2,D3	$\frac{1}{4}$ inch l.e.d. (2 off)
TR1	TIL414 (Tandy 276–145)
TR2	BC107 or similar
TR3	2N3704
IC1	074 bifet op-amp
IC2	MC4098B dual monostable
IC3	NE555 timer

POTENTIOMETERS

VR1	470k min. preset
VR2,VR3	1M miniature linear (2 off)

MISCELLANEOUS

S1,2	Miniature toggle switch s.p.d.t. (2 off)
S3	Miniature toggle switch s.p.s.t.

Case; light tube; battery clip and battery; electret microphone insert (Tandy 270–092); 2·5mm jack socket, p.c.b., PE 104, etc.

Note: If a shorter delay is all that is envisaged on the first trigger delay section, fit a 1µf capacitor instead of 10 µF for C5. This will then delay up to 400ms instead of 4s and give a more precise control over the range.

RECEIVER

The receiver p.c.b. (Fig. 5) should be offered up to the lid of the box before any parts are fitted to it. Then pilot holes (1mm) can be drilled through the lid of the plastic box where the potentiometers, switches, and l.e.d.s are fitted. This method should produce the most accurate positioning when offering up the completed board. The box can then be drilled and legended, Letraset and a fixer spray makes a reasonable job.

A second small board (a small piece of scrap p.c.b. material) is required to hold the detector transistor, or veroboard can be used. The detector transistor, TR1, is fitted on this, lining up with 30mm of tubing as in the transmitter.

The main board is assembled, starting with the two switches soldered through holes on the board. It may be necessary to elongate the holes provided on the board to permit the switch tags to pass through.

The other components can now be fitted to the board, leaving the i.c.s until last. The 4098 is a CMOS device and should be handled with care. The l.e.d.s are fitted to the board spaced away by approx. 10mm. This allows them to poke through the lid of the box. The potentiometers should be fitted last, and are wired to the main board by short solder spills. The shafts of these potentiometers should be cut down if required before fitting. The amount depends on the type of knob selected.

The boards in the receiver are best fitted with tags to solder interconnecting wires to. These tags should protrude through the copper side of the main printed board. The microphone, detector transistor, and battery leads (via S3) can now be soldered on.

When fully assembled, the completed board is fixed to the lid of the box, retained in the lid by the nuts on switches S1 and S2. An appropriate

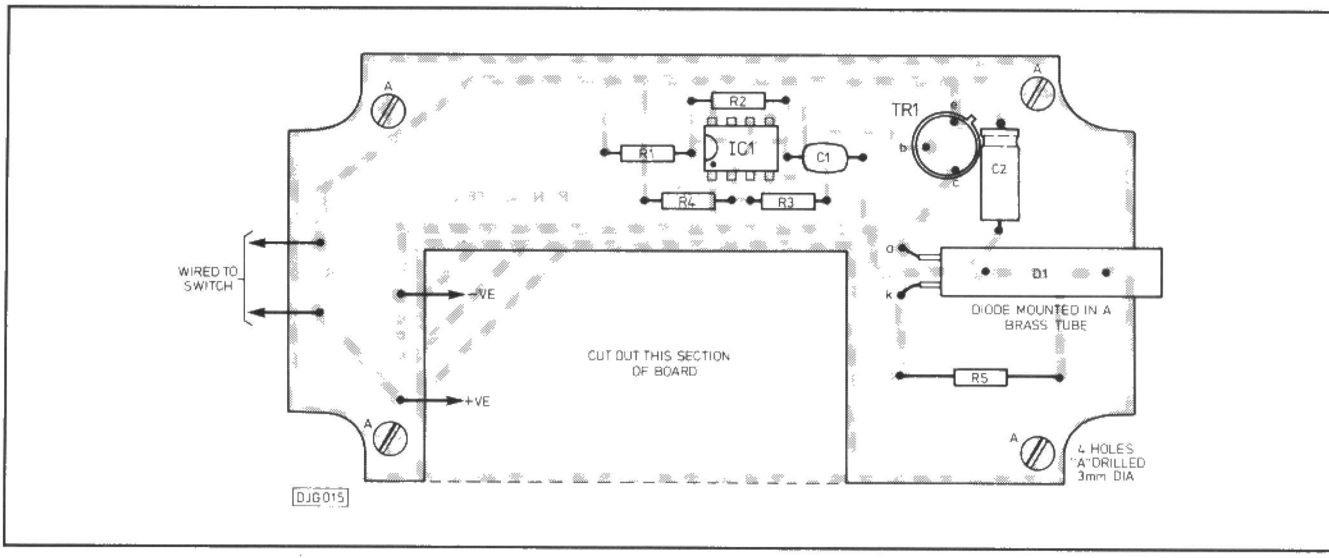


Fig. 4. *P.c.b. design and component overlay of the transmitter unit*

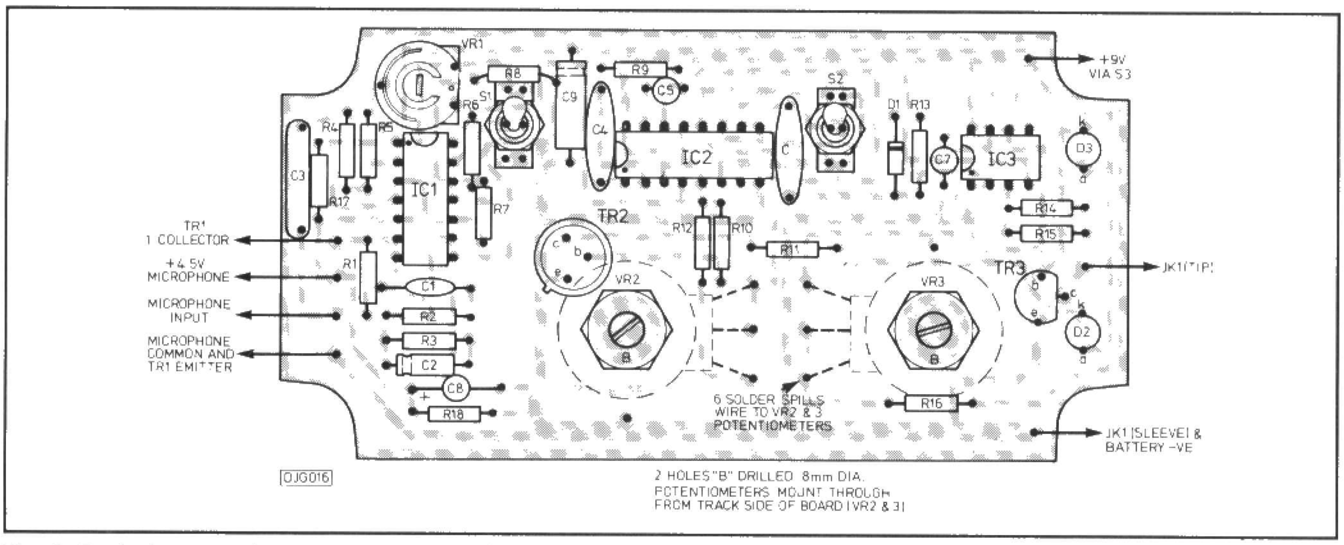


Fig. 5. *P.c.b. design and component overlay of the receiver unit*

spacer (14mm) can be used additionally if desired with a fixing nut and bolt. The nut on the printed board should be provided with an insulating washer to prevent any short circuits. The lower small board is fixed at one end of the box with two small 6BA screws to line up with the hole drilled in the case.

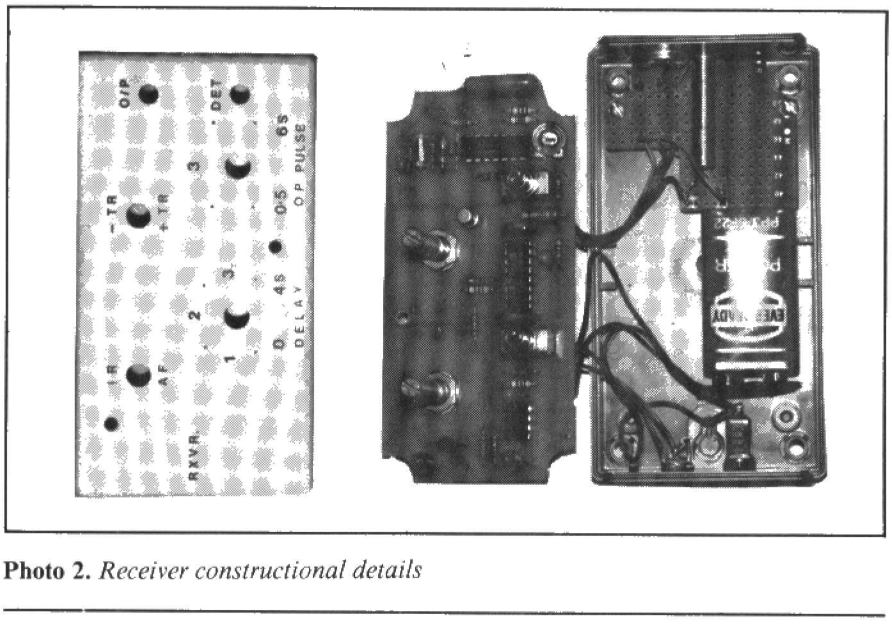


Photo 2. *Receiver constructional details*

TESTING

To begin testing, apply the 6V volt supply to the transmitter board, if possible, checking the current consumption, which should not be more than 40mA. If an oscilloscope is available, check for 1·5kHz pulses across the l.e.d. which should be approx. 1V pk-pk. If the pulses are significantly larger, and the current consumption very low, check the polarity of the l.e.d.

To test the receiver, connect the 9V battery, again checking current, which should be in the order of 20mA. The output l.e.d. should light up. It may pulse off briefly, but should normally remain on. Check with a voltmeter the junction of R17 and R18 which should be in the order of half the supply voltage. A 10% error on this is quite acceptable, more should be checked, in

particular check the current through the microphone which should be around 2mA.

Next, check the voltage at the output of each amplifier stage. This should be approximately half the supply voltage for all amplifiers bar the schmitt trigger, whose output is at 0V.

The two units can now be switched on together. Line up the transmitter and receiver on a flat surface, and switch both p.c.b. toggle switches upwards. The lower l.e.d. should light, indicating that the receiver is detecting the IR beam from the transmitter.

With both pots turned fully ACW, the action of breaking the beam should cause the lower l.e.d. to extinguish briefly, and the upper l.e.d. to go out for about 0·5 seconds. The control on the left, "delay", will introduce delay between breaking the beam, and the output l.e.d. indicating. The second control should alter the amount of time the output l.e.d. is off.

A double ended lead should be made up with a 2·5mm jack plug at each end, as shown in Fig. 6. This and the set-up can be tested with a 9V battery and a lamp wired across the jack which should indicate when the beam is broken, or with the selector switch moved, when sound occurs.

To use the units with a flash set-up, a hot-shoe mount with the plug cut off and substituted by a 2·5mm line socket, will mate with the cable already mentioned.

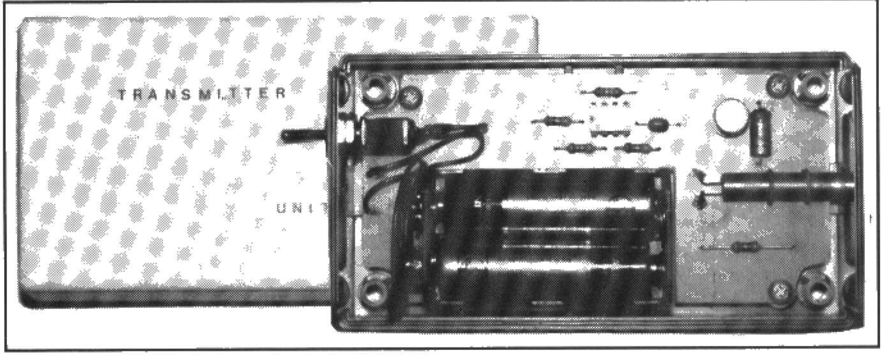


Photo 3. *Transmitter constructional details*

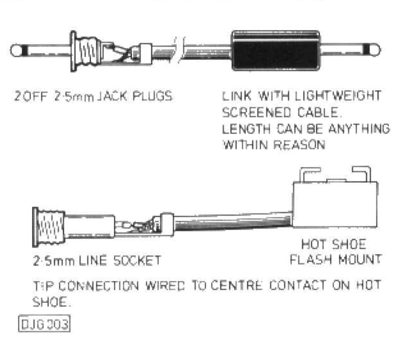


Fig. 6. *Jack-plug connections*

CONCLUSION

As mentioned earlier, the units have an approximate range of 1·5 metres. This may be reduced slightly if used in bright sunlight, due to the detector transistor saturating. Alignment is fairly critical, and can be assisted by placing both transmitter and receiver on a strip of wood whilst setting up.

If the units are requred for security purposes, the transmitter can be modified for 9 volt operation by simply changing R5 to 16Ω, allowing the two units to be fed from a common regulated power supply. PE

FROM THE EDITOR . . .

After twenty-one years at IPC, Practical Electronics is going through a great upheaval. I am using the change of ownership to examine whether the editorial contents of PE is what readers want. In last month's issue the magazine carried a questionnaire, replies to this are flooding in and have enabled me to undertake a preliminary analysis of what you, the readers of PE, want to see in future issues.

ANALYSIS

The analysis indicates that readers feel PE has not kept up with the constant changes in technology, a situation I intend to rectify. A substantial majority of PE readers possess a home computer, and consequently an interest in microprocessors, computer interfacing and computer related projects is expressed by many. This data is proving very useful in formulating future editorial policy. I am instituting editorial changes, but all PE's loyal and regular readers can rest assured that these changes will not be substantial and are aimed at improving editorial quality rather than altering the magazine's direction.

POLICY

The key element of the new editorial policy is good forward planning. This will enable the editorial department to thoroughly check all projects, it will also ensure that our advertisers are able to supply all the key components of a project on the date of publication. Good forward planning will also allow a continuity between projects. An example of this proposed continuity is given in the article 'Setting The Standards' in this issue; a common system of interconnection is the basis of any continuity between different projects.

NEXT MONTH—this issue has a very interesting set of major articles. The single board computer system (IEE1000) is continued with the completion of the power supply and the backplane. Also starting is the PE Hobby Bus—which will give a standard I/O bus for all home micro interface projects. For mariners the DF Beacon Timer will prove a valuable offshore navigation aid and for the workshop, a useful piece of test equipment is the Logic Checker project.

TECHNOLOGY EXPERIMENTS

Solar energy will be the first subject in a new series of feature articles on electronic technology experiments; the article will have particular emphasis on solar cells. For those interested in robotics there is an article on the biological basis for robotics system design. Finally, along with all our regular features, there is a project for electronic music enthusiasts—an Echo Reverb Unit.

I am sure you will find the May issue of Practical Electronics great reading.

NICK HAMPSHIRE . . .

SPACEWATCH

BY DR PATRICK MOORE OBE

PROJECT ULYSSES

Over the past few years it has been found that our knowledge of the Sun, our nearest star, is probably much less extensive than we have fondly believed. In particular there is the 'neutrino problem'; the Sun is emitting far fewer neutrinos than in theory it ought to do—as we know from the experiments being carried on at Homestake Mine in South Dakota and also in the Soviet Union. Neutrinos, which have no mass (or virtually none) and no electrical charge, are very hard to detect, and one way to do so is by interactions with chlorine, producing radioactive argon. At Homestake Mine, a vast tank of chlorine-containing cleaning fluid has been set up a mile below ground (to provide a shield against cosmic rays) and the experiment seems to be reliable. One solution would be to reduce the Sun's core temperature from 15.8 million degrees to only 14 million degrees; this would explain the paucity of neutrinos, but raises other theoretical problems.

There is also the problem of the solar wind. From information sent back from the deep-space probes to the outer planets, it seems that the solar wind is not 'slowing down' at great distances as had been expected. At present, however, most of our information comes from probes operating not far from the main plane of the Solar System. A new project, Ulysses, is designed to pass over the Sun's north pole, and obtain data from previously unexplored regions.

Ulysses is scheduled to blast off in May 1986, from the Shuttle Challenger and thence by a Centaur rocket. It will first go out to the region of Jupiter, arriving there in July 1987, and will use Jupiter's gravity to move the probe out of the ecliptic plane and swing it back sunward, so that in early 1990 it will pass over the north pole of the Sun. Experiments carried on the probe will deal with magnetic fields, solar-wind plasma, particles of various types, cosmic rays, solar X-rays, and cosmic dust. The mission will officially end in February 1991, though it is true that many recent missions have continued for much longer than expected.

THE REMOTEST GALAXY

Up to now the holder of the 'distance record' has been held by the quasar PKS 2000–330, which has an estimated distance of 13,000 million light-years; it was discovered at the Parkes Radio Astronomy Observatory in Australia, and optically confirmed at Siding Spring. Now the record may be challenged—this time not by a quasar, but by a galaxy!

The research has been carried out by S. Djorgovski and his team at Berkeley in California. Using the Lick 120-inch reflector, they studied the region of a faint quasar in Hercules, and discovered a separate object which proved to be a galaxy with an even greater red shift. Its magnitude is 24.5, but a reliable spectrum was obtained, and if the red shift is to be trusted the distance must be at least comparable with that of PKS 2000–330.

Of course, the Doppler interpretation of the red shifts for quasars has been challenged by a few astronomers, notably Sir Fred Hoyle, but the red shifts of the galaxies have been more universally accepted. If Djorgovski's work is confirmed (as there is every reason to expect), it will further strengthen the argument that the red shifts of all very remote objects are indeed cosmological. And if Hubble's constant holds good, we may come to the end of the observable universe at between 15,000 and 20,000 million light-years, probably rather closer to the lower figure—though we must al-

THE SKY THIS MONTH

This is still not a very good time for planetary observers. Mercury is on view as an evening object for the first ten days of the month, low above the western horizon for about half an hour after sunset, and between March 6 and 11 it is not far from Venus—though, needless to say, there can be no confusion between the two; Venus, at magnitude −3·4, is far brighter than any other star or planet. Both Mars and Saturn are morning objects, but neither is at all well placed, though by the end of March the magnitude of Mars has increased to 0·3, about the same as that of Saturn. Jupiter is virtually out of view throughout the month. There are no important meteor showers; the Arietids last from about the 14th to the 18th, but the hourly rate is always low. Neither are there any eclipses.

By now, of course, we will have the news from the Voyager 2 pass of Uranus. I will be able to give it, in full, in my notes for next month.

The brilliant winter stars are starting to be lost in the evening twilight, though Orion is still on view soon after sunset, and Sirius remains above the horizon during the early part of the evening. The Great Bear is in the north-east. Use the 'Pointers' the wrong way—that is to say, away from the Pole Star—and you will reach Leo, the Lion, the main spring constellation, with its first-magnitude leader, Regulus, and the characteristic curved line of stars which makes up the famous 'Sickle'. The rest of Leo consists of a triangle of stars to the east of the Sickle, of which the brightest is Denebola or Beta Leonis. In ancient times Denebola was ranked as being of the first magnitude. Today it is slightly below the second, and a full magnitude fainter than Regulus. It is one of several stars which have allegedly altered in brightness over the past two thousand years or so, but whether there has been any genuine change in these so-called 'secular variables' is a matter for debate. Denebola, which is a white star of spectral type A, does not seem a likely candidate, and on the whole it seems more probable that there has been an error in interpretation or translation. Another case concerns the Twins, Castor and Pollux, which are still high up. Castor, formerly regarded as the senior of the pair, is now about half a magnitude fainter than Pollux, but again it is hardly likely that there has been a real alteration.

Castor and Pollux point downward to the orange star Alphard, leader of the constellation of Hydra (the Watersnake). Hyrdra is the largest constellation in the entire sky, but also one of the dullest, and Alphard is its only star of note. It is reddish, and nicknamed the 'Solitary One' because of its isolated position; the magnitude is 2. It has been suspected of slight variability. This would not be unexpected but even if there are fluctuations the range is only a few tenths of a magnitude at most. Alphard is 85 light-years away, and is 115 times as luminous as the Sun.

ways bear in mind that this refers only to the *observable* universe, not necessarily to the universe itself.

COMETS: GRAVEL-BANKS OR DIRTY ICEBALLS?

During the first part of this month five probes will be on their way to a rendezvous with Halley's Comet. Two are Japanese, two are Russian and one is European—built by British Aerospace in Bristol, and successfully launched last July from French Guiana. On the night of March 13/14, Giotto is scheduled to pass right into the heart of the comet, and—we hope—send back close-range pictures of the nucleus.

Up to now we have known very little about cometary nuclei, because we have never been able to see them properly. When a comet has no obvious head, it is so far away that it is quite beyond the range of any telescope to show details; and when the comet draws in toward the Sun, the nucleus surrounds itself with an 'envelope' through which we cannot see.

The accepted theory, due initially to the great American astronomer Fred Whipple, is that a nucleus is a 'dirty iceball', and that when the ices are warmed the coma is produced—together with a gas tail (driven out of the coma by solar wind) and a dust tail (driven out of the coma by the pressure of sunlight). But not everyone agrees, and in particular there is a theory due to R. A. Lyttleton that the heart of the comet is more in the nature of a flying gravel-bank or flying sandbank. On this picture, each particle follows its own orbit; when the comet nears perhelion the particles collide, producing the effects we see. And if Lyttleton is right, then Giotto will show no 'dirty iceball'.

Lyttleton also doubts the existence of the so-called Oort Cloud, from which comets are thought to come; he believes that the comets are collected by the Sun during its journey round the centre of the Galaxy. Obviously we cannot see the Oort cloud; it is much too far away. But if Lyttleton's gravel-bank theory is found to be correct, then he may well be right also about the non-existence of the Oort cloud.

It must be said that Lyttleton and his supporters are very much in the minority, but this is one question which will be cleared up within the next week or so—provided that Giotto functions properly. Both Whipple and Oort will be at Darmstädt, in Germany, headquarters of the European Space Agency, where the Giotto pictures will be produced as soon as they are received from the Parkes radio telescope in New South Wales. I may add that I will also be there, and I hope to be able to give a full report in an issue of *Practical Electronics* as soon as possible. My view is that Whipple will be proved right and Lyttleton wrong; if not, then we must all do some radical re-thinking.

Meantime, the eccentric fringe has been in full cry, and all current disasters, both natural and political, are being laid at the comet's door. At a meeting of the Halley's Comet Society in Wembley, a band of demonstrators waved around a vast placard announcing that the end of mankind was nigh, and we had all better repent immediately. Another group forecast that the world would be destroyed when the comet reached perihelion. (As this occurred on 9 February, we will know that this particular forecast is wrong—if we were all still here in March.) On a lighter note, one man in Malvern claimed that the comet had made him lose two teeth—he broke them because they chattered so much when he was searching for Halley on a chilly night. I have my own personal disaster; on coming out of my observatory dome after photographing the comet I slipped, fell, and dislocated my shoulder and broke two ribs! But I fear that I must blame myself, not Halley . . . PE

(continued from page 15)

true 16-bit chips are still brutes to make!

Whatever happens about 16/18-bit resolution, domestic compact disc player quality is already so good that it shows up deficiencies in the original recording. For the first time home reproduction equipment can be better than professional studio recording technology. So studios are switching to digital recording.

There are two quite different technologies available. The cheapest relies on a domestic or industrial video recorder to capture the rapid data stream produced by a "processor" which converts a two channel analogue signal into pulse code modulation. A Sony PCM processor costs from under £1,000 and works to the same standard as compact disc (44·1KHz sampling, 16-bit coding). It can only be used to tape two sound channels at a time. Broadcasters and small studios use them to record stereo direct from a pair of microphones.

STATIONARY HEAD

The more expensive approach is stationary head recording. This can be used for taping more than two channels of sound at the same time i.e. for multitrack recording. The recording industry is currently trying to decide between two competing and incompatible technologies. Sony originated the DASH (digital audio stationary head) format, and is now backed by Studer of Switzerland. The tape runs fast past a stationary head which is divided into very small segments so that it records narrow parallel tracks on the tape.

DASH

Sony's 24-track DASH recorder uses 12·5 millimetre tape. It runs at 76 cm/sec past a recording head which is subdivided into 24 sections, one for each sound channel. The tape must accurately record 1·5 kilobits of data per millimetre. The next generation of DASH will double recording density and either allow the tape to run at half speed or record double the number of sound channels recorded. So far only prototype double density DASH recorders have been demonstrated because the heads must be made by thin film technology. Instead of machining the head gaps, they are etched by a photo technique similar to that used for micro chip production. A single density 24-track DASH recorder costs nearly £100,000 so only the most successful studios can afford to buy one.

ALTERNATIVE

Mitsubishi has developed an alternative stationary head system. The X-800 records 32 sound channels but uses 25mm tape. Mitsubishi claims its X-system is virtually immune from errors caused by tape blemishes because 8 extra tracks are recorded for the sole purpose of duplicating data recorded on the main tracks. Because DASH and Mitsubishi X-system tapes are not interchangeable, the recording industry is now trying to decide which system to adopt. Every week the two companies announce some new sale or deal with recording studios round the world. Already it seems certain that the recording industry is stuck with a split standard for digital recording. The first company in the field, 3M, has disappeared from the scene. 3M's very expensive stationary head multitrack recorder—which was compatible with neither DASH nor X-system—has sunk without trace. PE

SILICONE CONTAMINATION

BY GERALD KINGSBURY

"Silicones can travel, and when they do, the results can be disastrous"

WHEN in doubt, electronics engineers and amateur enthusiasts alike tend to attribute the snap, crackle and pop type of interference which plagues all manner of electronic equipment, to such causes as "airborne contaminants", "oxidisation" and "dirty contacts." Lay observers blame the aberrations on still more nebulous phenomena such as static!

Yet despite painstaking efforts to ensure apparatus is well maintained, audio equipment often persists in crackling like a bonfire, video displays fuzz momentarily, or jar the eyes with distortion, and computers vex their operators by crashing for no apparent reason.

HIDDEN MENACE

Varied are the reasons why electrical/electronic equipment does fail with such maddening inexplicability, but comparatively recent research has unearthed a hidden menace which may well be responsible for the majority of "open circuit" fault conditions, and it is a self-inflicted menace at that!

It is our propensity for using silicones to polish, act as release agents, lubricate, and conduct heat that gets us into trouble. It seems that our ally, the silicone, is also our enemy! Silicones can travel, and when they do, they bring disaster.

Scientists around the world are alerted to this less welcome effect of using silicones in an electrical environment. Researchers working for Hitachi in Japan, and others working for America's Bell Laboratories have demonstrated that unreacted silicones—often found in badly formulated *contact lubricants,* and many household furniture polishes—can cause havoc when used near, or actually on, relay and switch contacts. Further, the nature of abrupt failures due to silicone containing films is related to the degree of electrical energisation, or duty, of the contaminated contacts.

You see, it all stems from the fact that unreacted silicones are able, and indeed have a tendency to creep around on surfaces. Researchers discovered that failed relay contacts behind a central office panel had "dimethyl silicone" oil present on their surfaces. More worryingly, they discovered that this oil had spread over intervening surfaces and wires from silicone lubricated equipment several feet away!

The cause of contact troubles in telephone equipment has been traced to vapours rising from nearby silicone oil baths, while in another instance, silicone carbide crystals were found on the surface of a silver contact, despite the fact that the contacts had no silicone-based compounds between their surfaces. The crystals had appeared through migration from a silicone-based heat transfer compound applied to a thermostatic controller elsewhere in the equipment. The failed contacts were operating on a light load of only 12V d.c. and had survived a mere 7000 cycles before going open circuit.

CONSEQUENCES

The most common silicone fluids and oils are dimethyl silicones, which tend to spread over almost all types of surface, including relay contacts and their springs. The rate at which they creep around depends upon the nature of the substrate, the temperature, and on the fluid's viscosity. When the spreading offenders reach a set of contacts the temperatures brought to bear by arcing form the silicones into hard, rock-like crystals, notably silicone carbide. These crystals then cause a lack of electrical continuity with high contact resistance, leading ultimately to open circuit condition. The user of silicone contaminated apparatus therefore perceives a catastrophic increase in contact resistance, manifesting itself at first in sporadic, and then continuing "opens".

The damaging effect of silicones is promulgated by a Russian research paper which points out that whilst silicones have proved extremely valuable as insulation material in electrical systems, in many classes of rotary machines their use can lead to accelerated brush wear. This is presumably brought on by the formation of silicone carbide crystals.

The greatest concentration of silicone deposits—and hence the most harmful—are likely to be found in totally enclosed machines, or those with poor ventilation, says the report. "The increased rate of brush wear can be from 20 to 200 times the normal rate and, in exceptional circumstances, 800 times the rate."

Common sources of silicone compound contamination in electrical systems are the dimethyl silicone oils and greases used on associated moving parts. One example of this was identified by American Researchers studying a motor-driven interrupter, in which silicone oil was used as a lubricant for the motor and driving gears. The silicone oil quickly spread to the cams, and then the contacts they actuated. After a short time, the units failed!

WE'VE TAKEN A SHINE TO THEM

Another "vehicle" for silicone contamination is the *mysterious one* who comes around to clean and polish things when you are not there. Be that person housewife or contract cleaner, the aerosol mist polish incorporated in the cleansing arsenal is not only liable to put an external shine on enclosures containing switchgear—and that includes the humble telephone—but eventually render their contents unserviceable. What the "gleam-makers" do not know is that furniture polishes often also contain silicone fluids; so in schools and offices cleaners may quite unwittingly be the cause of data losses and read/write errors in otherwise carefully maintained computer equipment.

Gerald Kingsbury is the Managing Director of Electrolube Ltd. Electrolube manufacture and supply a range of solvents and lubricating compounds to remove and protect against silicone contamination.

Photo 1. *Silicone contamination, the hidden menace, caused by innocent use of spray polish*

And the mischievous antics of silicones do not end there. Some office copying machines release vapours containing silicone oils, black pigments and polymeric binders, in addition to the usual paper fibres. Alarmingly, a number of PBX machines have been rendered inoperative by the proximity of such copiers.

THEY'RE EVERYWHERE!

The use of silicones as encapsulants, potting compounds or sealants in the electronics industry is now widespread, but it can lead to grief when these materials are improperly formulated. Take, for example, the problems experienced with key-telephone units, which were traced back to silicone oils bleeding from a silicone compound used to encapsulate a reed relay. The invisible oils migrated over a printed circuit board and up onto relay contacts located over an inch away. Dimethyl silicones are frequently used to "plasticise" or modify the viscosity of silicone formulations, and these will bleed from the compound, given time.

In all of these instances the propensity of dimethyl silicone oils to spread has the effect of continually renewing the offending liquid film on contact surfaces, which in turn results in yet more black insulating deposits.

CALL IN THE EXPERTS

Hitachi's Production Engineering Research Laboratory looked at the problem in depth in an attempt to discover the composition of the contaminants on failed contact surfaces, and the process changes silicones into insulating film. The researchers examined an electrical control system which had broken down because of a failed relay.

The dust-proof relay consisted of a base with terminals, a coil, a magnetic circuit, armatures with a contact on top of each, leads between the terminals and armatures, a return spring, and a plastic cover. The silver contact contaminated with the carbonaceous black powder, and which was plated with 3 to 5μm gold, was operated about ten times a day. At 24 volts it was energising a 240 Ohm inductive load, and gave trouble after several months service. In the laboratory, the resistance of the failed contact was measured as over 100 Ohms. Because, in general, a contact coated with carbonaceous black powder seldom goes to such a high resistance it was concluded that the contaminants comprised something extra. Indeed, using a wavelength X-ray micro analyser it was discovered that these contaminants were composed of carbon *and silica.*

WHAT THEY FOUND

From their experiments, Hitachi researchers deduced that the following sequence of events takes place:

1) As the internal temperature of the relay rises due to coil energisation, low molecular weight organics are vapourised from the organic materials within the relay. These vapours fill the space inside the cover, during which time some are adsorbed by the contact surfaces.
2) In this state, if the contacts are operated repeatedly, these adsorbed organics are decomposed to silica, carbon and gaseous materials by the contact arcs or molten metal bridges.
3) A vicious circle follows. The more carbon that adheres, the more organic vapour is adsorbed, and as a result, contact arcs occur more readily. The contaminants accumulate rapidly towards failure point.

By mixing carbon and silica together in powder form, and in differing proportions, the researchers also discovered that contacts polluted at under 40 per cent silica did not fail. This curious 40 per cent point coincided

WHAT ARE SILICONES?

Look up Silicones in *"Comprehensive Inorganic Chemistry"* published by Pergamon Press, and you will find this description: "The organopolysiloxanes, popularly known as silicones, consist of a framework or backbone of alternate silicon and oxygen atoms clothed by certain selected organic groups attached directly to the silicon atoms."

Such qualities as *"thermal stability"* and *"chemical inertness"* are cited, the latter meaning resistance to oxidation. Silicones are unknown to the natural world, with no relatives or precursors in it, and in reference works the quality *"unnaturalness"* is referred to. High molecular weight silicone polymers are insoluble in organic liquids, with the useful outcome that they are "bland and protective" towards human skin.

A surface coated with methyl silicone has a high contact angle to liquid water, which means it is water repellent. Only a few of the theoretically possible silicone polymers are considered useful and therefore manufactured. But certain silicones are used widely in liquid form to put a finishing film on paper, textiles and masonry. Another application is as a bonding agent in glass fibres.

–Si–O–Si–O–Si–O–Si–O–

with the point at which the resistivity exceed 100 Ohms. They concluded that, in the initial state, the contaminants are carbon rich, but that the carbon is gradually burned off by arcing (yielding carbon dioxide) while the silica remains behind. This explains another observed phenomenon, that the percentage of silica in the mixture varies in proportion to the number of contact operations, and the catastrophic failure point.

THOU SHALT NOT . . .

There are a number of steps which can be taken to reduce this kind of failure. The most obvious precaution is to avoid the use of silicone oils, greases and fluids altogether in the locality of contactors. Even high molecular weight, high viscosity silicone lubricants generally have low molecular weight fractions that tend to creep from the base material. Silicone mould releases should not be used for moulded parts, and silicone materials used to coat, encapsulate, insulate or pot electronic and electrical components should be carefully selected and formulated. The results of experiments designed to discover ways of avoiding this class of failure are now widely known to many scientists.

There are other problems to guard against. In the very smallest concentrations the presence of silicones will cause problems with paint and coating adhesion. Silicones are cunning too, for even if printed circuit assemblies are cleaned in a tank of Arklone of Freon (trichlorotrifluorethane) any silicones on the board will dissolve in the solvent and effectively contaminate further boards cleaned in the solvent.

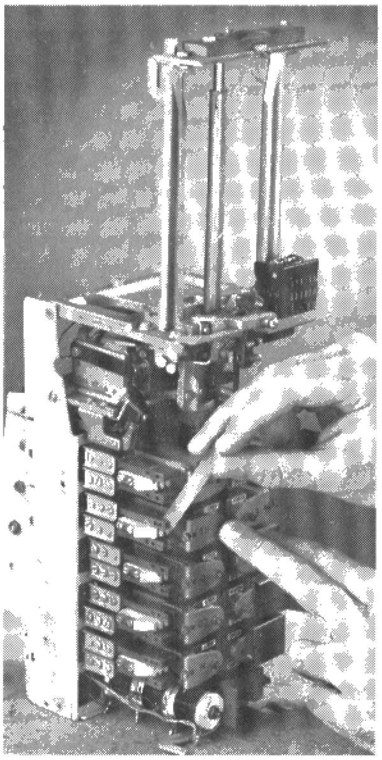


Photo 2. *Special cleaning tools, now available, used to overcome silicone contamination*

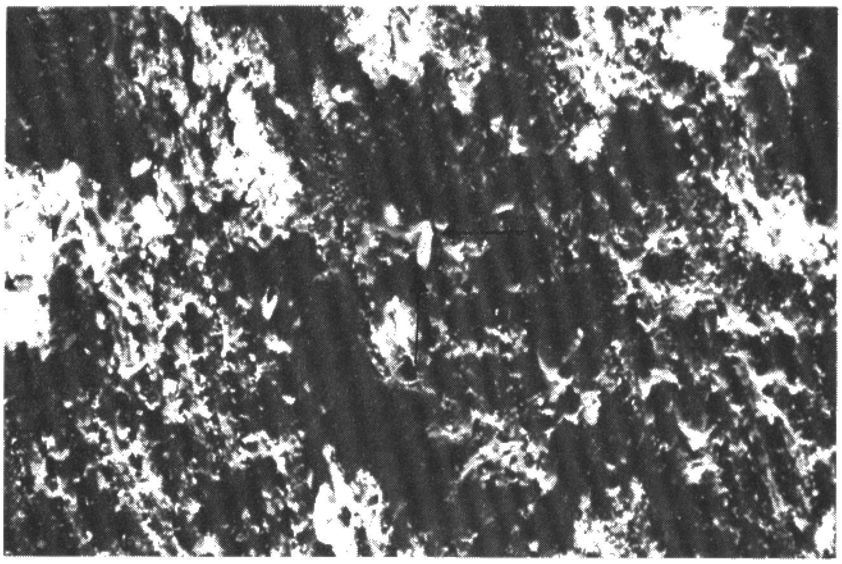


Photo 3. *Electron micrograph showing a crystal of silicone contamination*

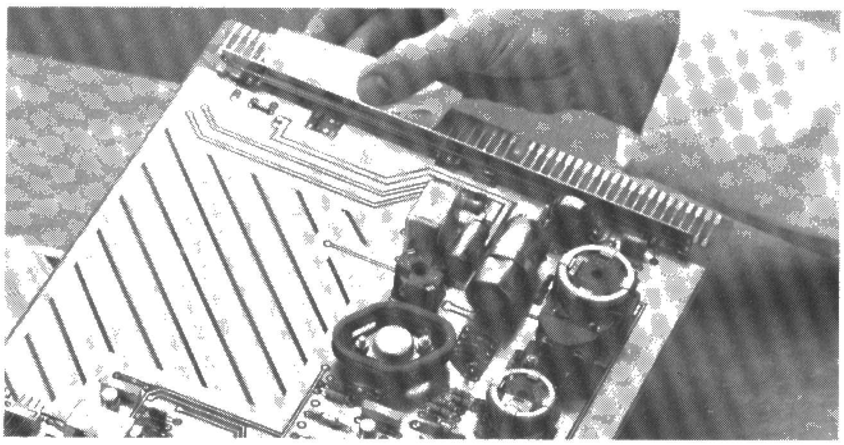


Photo 4. *Use of solvent impregnated cloth to guard against contamination*

PRODUCTS RETHINK

Electrolube has been aware of the problem of silicone contamination since the early 1960s when it launched the pioneering research and development programme which led to the introduction of the 2 and 2X range of non-silicone based lubricating products.

Continued development work by this company has resulted in one of the most comprehensive ranges of non-silicone based products for lubricating, cleaning and protecting electrical and electronic components.

Eltinert contact lubricants, for example, are inert to all plastics tested and can be used to break down silicone compound crystals so that they are easily removed. Continued use of Eltinert will prevent the reformation of the crystals and, of course, if Eltinert is used as a lubricant initially, the problem will not occur.

Electrolube has also developed a range of coatings designed to protect printed circuit boards. Awareness of the potential problems resulting from unreacted silicones played an important part in the formulation of these products.

Electrolube's Heat Transfer Compound is a silicone free preparation for efficient and reliable thermal coupling of electrical and electronic components to heat dissipating surfaces.

The amazing properties of silicones have become an increasingly integral part of our lives, but now it seems we must learn to live without them again in some areas. Progress . . . there's always a catch! PE

INGENUITY UNLIMITED

A selection of readers' ideas

MONITORED OSCILLATOR

Simple resonant measurer of inductance, capacitance or frequency plus any-waveform converted to a pure sinewave or sinewave oscillator

THIS simple circuit uses the principle that an inductor and capacitor in parallel can be put in the negative feedback loop of an operational amplifier where it will act as a wavetrap at one frequency only, the resonant frequency. If a signal is fed into the amplifier at any other than the resonant frequency, there will be no gain. If positive feedback is then applied the circuit will oscillate at the resonant frequency.

By using of a chart which relates frequency, inductance and capacitance, one can find the unknown, providing two of the variables are known. The circuit provides a very simple way of measuring, for example, inductance providing a known frequency and capacitor can be used to obtain resonance. This circuit is designed for audio frequencies but R.F. could also be covered. I have not developed such a circuit.

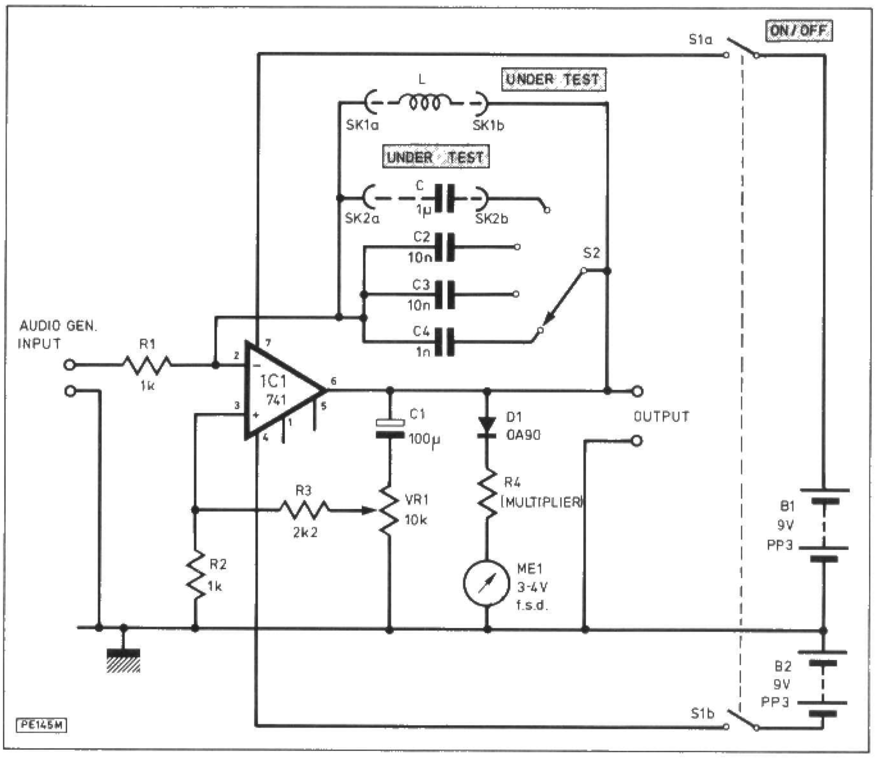


Fig. 1. *Monitored oscillator*

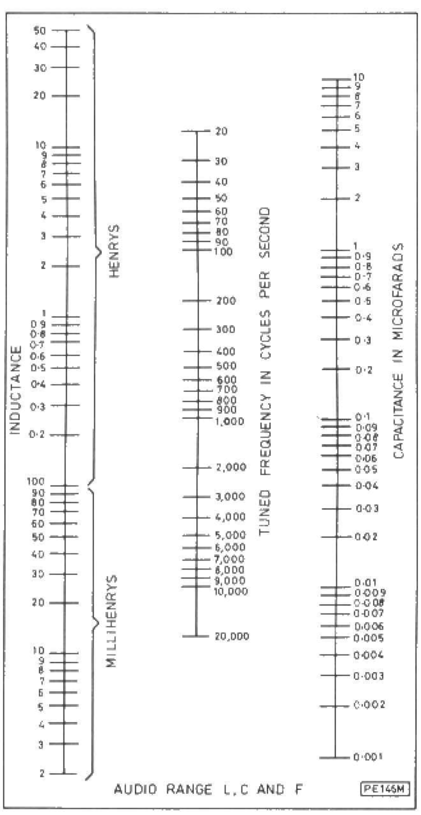


Fig. 2. *Frequencies chart*

Fig. 2 shows the frequency chart.

To measure an unknown inductor, connect the input to an audio generator and the unknown inductor to "L under test". Use a known value of capacitance connected at "C under test". Vary the incoming frequency until a reading is given on the voltmeter whilst also varying VR1 until a sharp peak is observed at a particular frequency. VR1 must not be advanced too far or the circuit will self oscillate. To measure capacitance proceed in a similar way except that a known inductance should be connected. For frequency measurement use a known inductance and capacitance.

If an oscilloscope is connected at the output a very good sinewave will be present at resonance. This will still be so even if a square wave source is used at the input! Indeed, practically any waveform input may be used and will yield a good sinewave output at resonance. Furthermore, if the input is shorted and VR1 increased (towards C1) the circuit will go into self oscillation and produce an excellent sinewave provided the positive feedback is not too great.

The "goodness" (Q) of inductors and capacitors can be estimated by the ease with which they will go into resonance and the sharpness of tuning.

No values are shown for R4 and ME1. These form a d.c. voltmeter with D1 rectifying the output. Almost any d.c. voltmeter of around 3V to 4V f.s.d. will do. The prototype uses a 20k resistor in conjunction with a 200µA moving coil meter. The ohms-per-volt figure times 3 or 4 of the meter will give a value for R4. For example, a 50µA movement would be 20,000 ohms-per-volt, so use 60k to 80k. None of the component values are critical with the exception of any standards used for L1 or C1 or the input frequency.

The prototype was made up in a small plastics box about 150 × 75 × 50mm. This was fixed to a piece of plywood having the chart glued on. The two PP3 batteries were fitted inside and a small moving coil meter installed. This is very convenient to use. A straight-edge on the chart finds the unknown, given the other two variables. Flying leads and croc-clips are used to connect the capacitor or inductor.

B. G. J. Wallwork,
Cookridge,
Leeds.

UNUSUAL CLASS-A AMPLIFIER

High quality audio reproduction at very low cost

HAUNTING the old ghost of how to make the best possible low-cost audio amplifier, suitable for the home-constructor's, often somewhat limited, measuring and testing facilities, I came upon this idea. A quite unusual, and yet very simple circuit, performing high quality audio reproduction at a very low cost.

It consists of a long-tailed pair, TR1–TR2, plus three current mirrors. The non-inverting transistor TR2 drives the positive output transistor TR7 via TR6. Since TR6–TR7 form a current mirror with different emitter-resistor values, the current flowing through TR7 will be approximately 460 times (R3/R4) higher than the one through TR6, thus producing the current necessary for driving the speaker. The same of course goes for TR8–TR9, being driven by the inverting input transistor TR1 via the current mirror TR4–TR5.

Since no current amplification takes place in TR4–TR5, the current driving TR8–TR9 is equal to the one driving TR6–TR7, if TR1–TR2 are in balance. (The only function of TR4–TR5 is to invert the current flow from TR1 to TR8.) Thus the quiescent current through the output rail depends on the current flowing through TR1 and TR2. This can be set by adjusting VR2, since Ic TR1 + Ic TR2 = Ic TR3, and TR3 functions as a constant-current generator. This also makes the circuit less dependent on variations in supply voltage. Furthermore it provides output current limitation, since the maximum drive current from TR1–TR2, and thus the output current, will at no time exceed twice the Iq.

For adjustment, turn VR2 (starting at max. resistance) until the quiescent current through the output rail is approximately 600mA (0·24V across R4), and VR1 to set 0V at the output. Repeat until the desired condition is established, before connecting the speaker.

Note that TR6 and TR7 must be mounted close to each other at the heat-sink to prevent thermal run-away. The same of course goes for TR8–TR9. Don't forget that a class-A output stage gets hot! For TR4 and TR5 one can use any general purpose *pnp*-transistor, but make sure that it will operate at the full supply voltage. Note also, except TR3, TR4 and TR5, the rest are darlington types.

Preferably all transistor pairs should be matched, but this is not strictly necessary, except for TR4 and TR5. With component values as shown, the amplifier will deliver some 8 watts into an 8 ohm load. This of course can be increased by increasing supply voltage and quiescent current, although it should not be taken too far.

J. Moller,
Copenhagen,
Denmark.

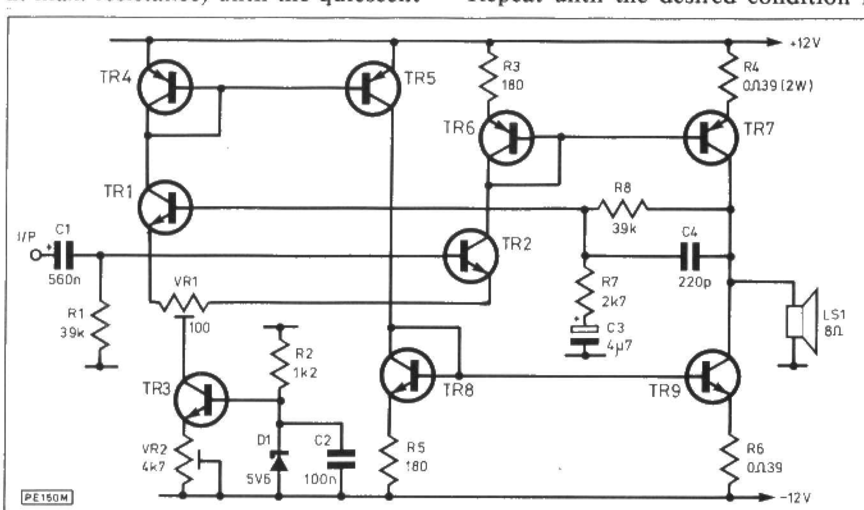


Fig. 3. *Class-A amplifier*

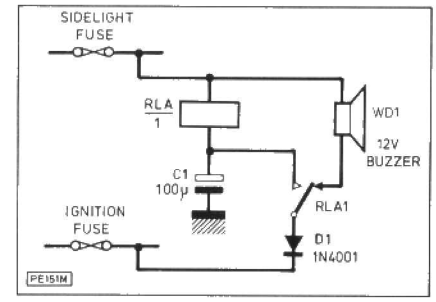


Fig. 4. *Headlight alarm*

CAR HEADLIGHT ALARM

Next winter, make sure that your car will start

THIS circuit was designed two years ago, when I suffered two flat batteries on consecutive mornings, to combat this problem. The circuit cost just over £2.00 to build and has successfully been in operation since.

The circuit takes its power from the sidelight and ignition fuses. Diode, D1 isolates the circuit when either the ignition is on or the lights are off, when a warning would not be wanted.

The circuit has two modes of operation. When the lights are switched on with the ignition on, as would be the case during normal driving, both fuses will be at +12V and so no current will flow. However, if the ignition is now switched off without the lights also being switched off, the ignition fuse will now be at earth potential and current will flow through the buzzer and give the required warning.

If the lights are required as parking lights then the relay comes into operation. If the sidelights are switched on while the ignition is off then C1 causes the relay to momentarily operate. The contacts, therefore, switch over diverting the current from the buzzer and latching the relay, thus suppressing the warning. When parking, the lights are simply switched off and back on, to halt the warning.

S. L. Jones, Pittingham, Durham.

REGULATOR +10V AND +5V

THIS circuit provides stabilised, +10V and +5V, supplies from an unstabilised input of +11V to +20V. It can be used for powering op-amp circuits from a single supply using the +5V supply as a centre reference supply.

A 7805 provides the +5V output and is used as the reference for the +10V supply. D1, a 5V6 zener diode ensures the output is 5V above the +5V supply via the amplifier transistor, TR1 and the series pass transistor TR2. Using a *pnp* series pass transistor means that the input-output differential voltage can be as low as 0·5V whilst maintaining regulation.

K. Wevill, Ratby, Leicester.

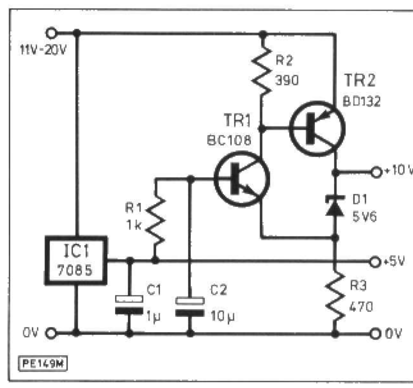


Fig. 5. *Regulator circuit*

ROBOTICS REVIEW

By NIGEL CLARK

Our regular look at robotics in education and industry

THE world of the Alfreds from Robot City Technology of Milton Keynes is expanding. As announced in *Practical Electronics* two months ago the company has developed a bigger version of the Alfred I known as Alfred II, which is now available with the first orders having been sent out.

The design is based on the meccano-like appearance of the Alfred I, it being a traditional five axis arm with gripper, powered by servos with closed loop control and driven by a toothed belt. However, the construction is far more rugged.

MODULAR CONCEPT

Alfred I at a price of about £200 and with a modular building concept is intended as an introduction to robots with the possibility of expansion later. Alfred II is selling for about £1,300 and is aimed at higher education but is also strong enough to be used in some light industrial applications.

The larger Alfred has a quoted lifting capacity of 2kg, although the makers say that it has lifted 3kg, whereas Alfred I can only lift 170gms. Its reach at 580mm is greater than the 380mm of the Alfred I, with the waist being able to move through 270 degrees, shoulder through 110 degrees, elbow 135 degrees, wrist pitch 180 degrees and roll 180 degrees. It also has an on-board Z80-based processor which can accept up to 200 steps being entered from a keyboard. In addition it can be controlled by a BBC B and Spectrum through the serial port.

The development of an on-board processor and using a serial rather than parallel port have been adapted for the Alfred I and the parallel port is being phased out.

Alfred I is breaking into the export market with the European and American markets being studied. One problem which has been encountered in some parts has been the name. Apparently in some German-speaking countries Alfred is a well-known television character who beats up his wife regularly. Robot City has decided that rather than be associated with that sort of character it preferred to change the name, so Alfred is now known as Pico in those countries.

Not so successful has been Reekie Technology with its Reekie Universal Robot, which was featured in *Practical Electronics* last year. While it has attracted interest from a large number of enthusiasts, none have so far come forward to buy one.

The company saw the RUR as the first step towards creating a low-cost device which people would accept as looking like a robot but also performed some quite complicated manoeuvres. Before its introduction the market was limited to the toys from Tomy, Omnibot, Verbot and Dingbot and for a short time the Androbot range or the much more expensive Hero 1, which was considered for the education market.

RUR, selling in kit form for about £450, is a mobile robot with a central processor control and battery-driven motor. A serial output allowed control from an outside micro. It was built so that it could be expanded with the addition of a number of add-ons such as sensors so that it could gain some idea of its environment.

However, the lack of response has meant that the development of further add-ons is a low priority at Reekie for the moment.

"It is incredible," said a spokesman. "We were warned that it might take a while for the product to get established but we did not think the reaction would be as low as this."

In the meantime the company is concentrating on its more successful lines. These include the Cepek Scara robot which was also launched last year but has been selling quite well and the mobile robot for working in hazardous environments such as fires or where there is a suspected unexploded bomb.

But the Universal has not been forgotten and if there is a sudden burst of interest, Reekie is ready to respond.

COMMOTION

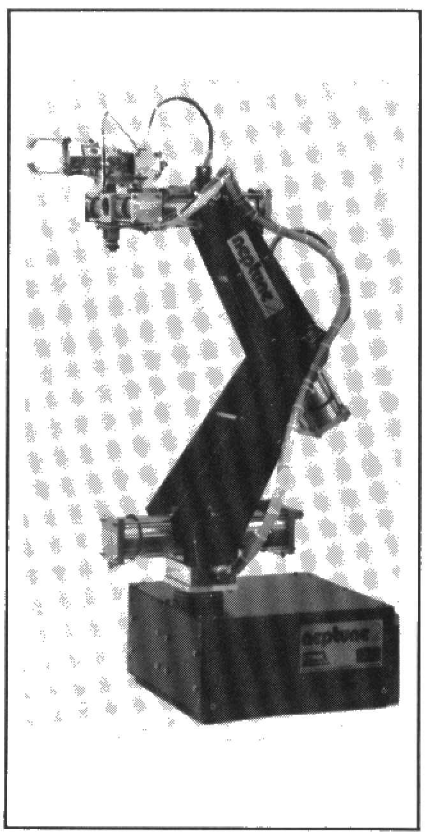
Commotion of Enfield has produced a new power supply which can cope with the extra demands for power with the increasing number of add-ons being connected together. It is intended primarily for the schools market but that does not preclude the home enthusiast from taking advantage.

Tim Coote of Commotion said that power supplies at present did not push out enough power for all the devices that were being run off them. His supply has two outputs one producing 5 volts at a rate of 1 amp and the other switchable between 6 volts and 12 volts at a rate of 4 amps. The switchable output levels are both variable by 1 volt either way.

BEASTY SERVO

Coote says that the supply, which sells from £55, is completely protected and idiot proof. All the possible incorrect connections have been considered and the device has been made so that nothing serious will happen whatever is done to it.

In response to popular demand the company has also produced a gripper for its simple Beasty arm. In its original form the 3-axis Beasty only had a hook or an electromagnet for picking



up things. Now, however, for £15 it is possible to add a two-fingered gripper.

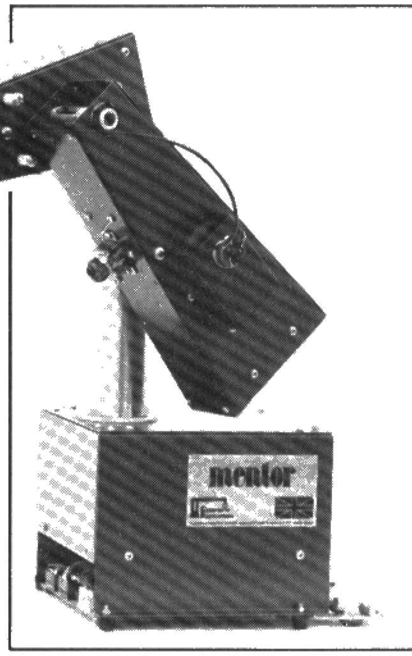
The upgrade kit includes another Beasty servo and instructions on how to adjust the building of the arm. Because the arm is so small and light slight changes have to be made in its construction to allow for the extra weight of the servo and gripper on the forearm. The rest of the servo-driven arm, which costs in kit form about £120 and runs off the BBC B with the help of a thorough and well-written manual will be the same.

ARMS TO THE GULF

Cybernetic Applications continues to develop its range of arms and accessories. The latest addition is a measuring gauge to go with its work cell.

The gauge measures the width of objects as they pass along the work-cell's conveyor belt. The objects can then be either accepted or rejected, sorted into various sizes or statistics calculated of the different sizes. It is available now and works with Cybernetic's full range including the Neptune, Mentor, Naiad and Serpent.

The company is also expanding into new markets overseas. It is still waiting for orders to flow in from its agent in Russia but in the meantime it is selling to other exotic locations. The latest is an order for most of the company's range from a research establishment in Bagdad, Iraq. Dick Becker, managing director of Cybernetic, said that there were no problems with the order except that the arms should not be addressed to the Persian Gulf. The Iraqis prefer to call it the Arabian Gulf.



Despite the failure of the First European Personal Robotics Conference and Exhibition held last year in London it is hoped to organise a similar but more successful event this year, again somewhere in London and in July.

A number of professional bodies which have an interest in the robotics field have been approached to see if they would be interested in helping to organise the event. They include the Institute of Electronic and Electrical Engineers, the Institute of Mechanical Engineers and the British Computer Society.

The optimism that a conference could be a success in Britain is based on the growing interest being seen in robotics particularly in education and the experience of the two personal robotics conferences in the States in the last two years, first in Albuquerque and last year in San Franscisco, which attracted a number of visitors from Europe. PE

CURRENT AND VOLTAGE MONITOR

Provide cost effective p.s.u. monitoring with a d.p.m. and a minimum of components

THIS circuit was designed to enable a digital panel meter (d.p.m.) to monitor the output current and voltage of a variable power supply with the minimum of switching.

IC1, a 741 op-amp is configured as a differential amplifier which gives an output proportional to the voltage drop across the series pass regulator transistor emitter resistors and is independent of the p.s.u. output voltage. The gain of the amplifier is approximately $\frac{1}{6}$. This is to ensure that the voltage at the non-inverting input of IC1 does not exceed the op-amp +Ve supply. The values given enable the circuit to work with p.s.u. output voltages up to 6 times the op-amp +Ve supply voltage. IC2 amplifies the output up to the level required by the d.p.m., typically 0 to 2V.

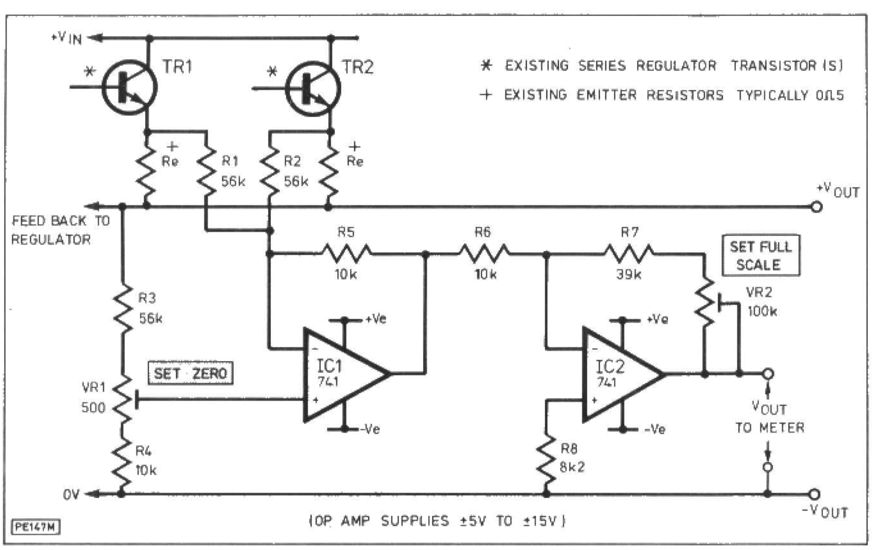


Fig. 1. *Complete circuit diagram*

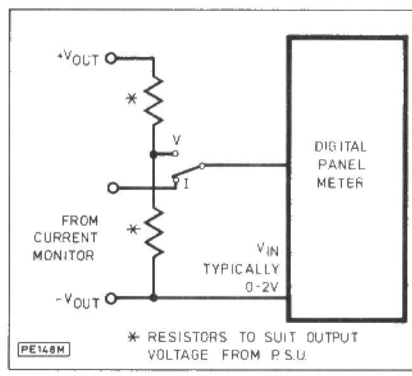


Fig. 2. *D.p.m. connections*

Fig. 2 shows the connections to the d.p.m. to enable the p.s.u. output voltage and current to be monitored.

The op-amp power supplies can be derived from the d.p.m. or a separate +Ve regulator and negative voltage converter such as the 7660 fed from the unregulated input. The set zero control should be adjusted for a reading of zero with no load on the p.s.u. Adjust the set full scale for a reading equivalent to the load current.

K. Wevill,
Ratby,
Leicester.

INDUSTRY NOTEBOOK

BY NEXUS

What's happening in the electronics world—and down in the sewers

STC ALL SET FOR RECOVERY

Standard Telephone & Cables is beginning to get back on its feet financially after a disastrous 1985. In August last year it reported a first-half net loss of £8·7 million—compared with a profit of £44·4 million in the previous year. The share price plunged, to put the company among the worst performers on the stock market. In the same year the then chairman, Sir Kenneth Corfield, resigned.

Rescue action, however, was very prompt. By September the company had brought in a new chief executive, Arthur Walsh, who came from Marconi (GEC). He immediately started a major cost-cutting exercise, aimed at restoring confidence in the financial world. Inevitably, heads rolled, both in the board of directors and at lower levels. Following the GEC formula, authority for making important decisions has been decentralised and now the managers of individual plants within STC have much more autonomy.

Bureaucracy at head office has been severely pruned and the company is moving out of its plush h.q. in the Strand, London—at which I confess to having enjoyed several unnecessarily lavish meals in the course of duty. (Message to the board: I'll be quite happy with a cup of tea and a biscuit in the future.)

On the electronic components side alone, the new board of directors has removed about 150 people and reorganised the management of the company concerned, STC Components Ltd. More jobs will be lost when this part of the group closes its tantalum capacitor plant at Aycliffe, Co. Durham, early this year.

One of the new STC directors is actually an old hand in the electronics industry: Sir Raymond Brown. At the beginning of his long career, as plain Mr Brown, he worked for Redifon on radio communication equipment and for Plessey. In 1950 he was one of the two founders of Racal. (The 'Ra' in the company's name comes from Raymond.) In later years Brown became widely known through his Ministry of Defence job as a kind of super-salesman for exporting British-made military equipment. More recently he returned to the electronics industry as chairman of Muirhead.

A DOUBLE LIFE

What seems extraordinary to plain folk like electronics engineers is that a company such as STC can go through such violent financial and management upheavals while still performing a perfectly stable and successful role in engineering and manufacturing. STC is an old-established, highly respected company which continues to get substantial orders from important customers. Just recently, for example, it has won a £50 million order from British Telecom for exchange equipment, a £4 million one from the USA for optical fibre cables, and a £1 million order from China for optical transmission equipment. Last year STC bought ICL (International Computers Limited) and thus added computers and data transmission to telecommunications to become a full-blown information technology group.

It's a paradox of the business world that product development, manufacturing and sales can carry on quite successfully while, at the same time, the management of the people, resources and finance can go badly wrong. There must be some structural weakness in systems that allow this dissociation to occur.

BRITAIN'S COMPUTER PAST

A recent trip to the Science Museum, South Kensington, served to remind me how ICL, now part of STC, actually came into being. I went to see the remains of the pilot model of the ACE (Automatic Calculating Engine) developed by the National Physical Laboratory during the 1950s. This research machine was eventually used as the basis of a commercial product, English Electric's DEUCE computer. Similarly Manchester University's pioneering work on digital computers was put into commercial form as the Ferranti Mark 1.

In those early days there were, on the one hand, university, industrial and government research laboratories who understood and constructed digital computers and, on the other hand, business equipment manufacturers who couldn't understand or develop computers but knew a lot about business data processing as it was then practised. Inevitably, the two sides got together. In addition to the two partnerships mentioned above, British Tabulating Machine Co. teamed up with GEC, Powers Samas with Ferranti, and National Cash Register with Elliot. Later, Lyons Electronic Office (LEO) joined forces with English Electric to form English Electric Leo Computers.

Then the massive competition from IBM and other American computer giants became too much for these individual UK partnerships and eventually they all came together for protection in the form of International Computers and Tabulators (ICT). This was the forerunner of ICL, which therefore became virtually the repository of the British main-frame computer business.

MILITARY ELECTRONICS

A gremlin in the February issue of PE made my comments under 'If peace breaks out' end rather mysteriously with Groucho Marx, the real end-piece being lost.

Having said that the UK electronics industry is heavily dependent on military electronics business and particularly on Ministry of Defence spending, I started to suggest that the possibility of an end to East-West tension and a consequent cessation of the arms race would bring about considerable changes. My conclusion, accidentally deleted, was that if the electronics industry really sees a viable future for its customer *Homo sapiens* it should be considering what to do in the absence of a fear-induced market for military equipment. Those apologists who try to justify military R&D effort by pointing to the benefits of peaceful spin-offs should start considering these spin-offs as primary developments and products. If these products are really so beneficial to us they should be worth making and selling in their own right.

ELECTRONICS DOWN THE TUBE

Every time you flush the toilet or pull the plug out of the bath or kitchen sink I don't suppose you give a moments thought to how the domestic effluents are safely and swiftly carried away from your household. And you may now ask what this has to do with electronics.

Well, there is in fact a small but growing sector of the UK electronics industry which is deeply concerned with this process. It consists of about half a dozen small companies who make closed-circuit television equipment specially designed for the mucky business of inspecting sewers—mainly the pipes which are too narrow to be entered by human inspectors. Two such firms are Telespec Ltd and Rees Instruments Ltd, both from near Woking, Surrey.

The basic reason for the emergence of this TV inspection technique is that Britain's sewers are crumbling. Many were built over a hundred years ago in response to the concentration of population in towns following the Industrial Revolution. They did much more for public health than medical science could manage and largely got rid of cholera epidemics in London and other cities. But the old sewer pipes are now disintegrating at an alarming rate. Local and water authorities are busy on an almost permanent programme of repair.

To dig up old pipes laid under busy thoroughfares and buildings would cause far too much disruption, socially and economically, so many of these pipes are being re-lined with plastics materials, working from a manhole at one end. This is where the special immersion-proof CCTV equipment comes in. It is used first to inspect the initial state of the pipes and record the nature and position of the damage. Then it is used to observe and control the operation of remotely controlled water-jet cutting machines which travel along the pipes and clear away all kinds of obstructions to the re-lining process. Finally, after re-lining, the TV equipment is used again for a final inspection of the work.

LARGE PROPORTION

A large proportion of the output of these small firms is exported for use in similar sewer repair work abroad. What happened in Britain during the 19th century also happened a little later in the rest of the industrialized world. The steady disintegration of old sewer pipes throughout North America, Europe and all countries which are now industrializing and attracting people into large conurbations should provide plenty of future business for this little-known sector of the UK electronics industry if it manages to stay competitive on price and delivery.

PHILOLOGICAL FOOTNOTE

Nexus is my name, and my nature is to connect. Of course, this pseudonym refers both to the fact that I join with you in communication and the fact that electrical connection is at the very heart of the electronics business.

Also appropriate, perhaps, is the somewhat derogatory phrase 'the cash nexus'—meaning that many human relationships are based not on purely human values like the concept of duty but exist only through money transactions. Thomas Carlyle, the 19th-century historian and philosopher, probably originated the phrase in his essay on Chartism. He refers to "epochs when cash payment has become the sole nexus of man to man." I wonder if EFT (electronic funds transfer) would have made any difference to the old curmudgeon's distaste. PE

SCRATCH AND RUMBLE FILTER UNIT

BY D. STONE

Audio enhancement unit for stereo hi-fi systems —featuring switchable filtering

When making audio tape recordings, noise on the tape can become annoying. This noise can take two forms, the first is high frequency 'hiss', and the second is low frequency 'rumblings'. The high frequency hiss can be caused by the tape medium and/or the amplifier. The low frequency noise is less noticeable and it is generally caused by the record or the record deck.

To try to combat the problem of noise, the audio enhancement unit consists of stereo scratch (high frequency reject) and rumble (low frequency reject) filters. These filters have switched frequency responses in order to control the filter for the correct degree of band reject. The scratch filter has switchable cut-off frequencies of 13kHz, 8kHz and 3·5kHz. All frequencies below these are passed unaffected by the scratch filter, all frequencies above the cut-off frequencies are attenuated by 12dB per octave in each channel.

The rumble filter cut-off frequencies are 30Hz, 60Hz and 110Hz. This filter will pass any signals unaltered if they are above the cut-off frequencies and attenuate signals with 12dB per octave below these frequencies. The rumble filter in the 60Hz and 110Hz positions will remove any mains hum from the signal. The 110Hz position will also remove power hum if it is due to rectified mains, i.e. caused by the power supply.

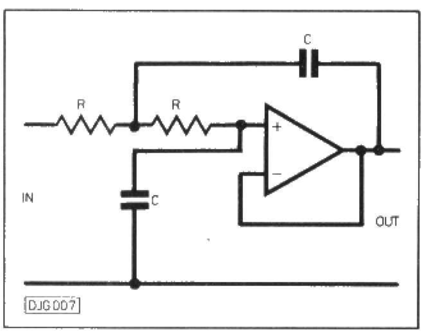


Fig. 2. *Second-order filter*

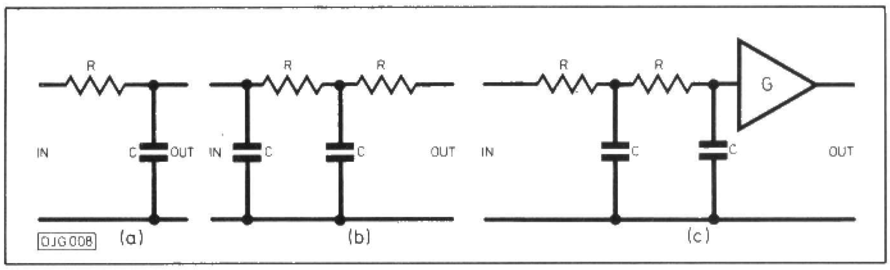


Fig. 1. *Filter variations*

CIRCUIT DESCRIPTION

The project is based around two identical halves, one for each of the two channels. Each channel is made up from a low pass filter followed by a high pass filter. Switches are provided to bypass the filters if required.

The filters are second order Sallen & Key configuration filters. The standard first order filter for a low pass system is shown in Fig. 1a. This filter has a corner frequency of 2πCR. The Roll-off is 6dB/octave. In this circuit, the capacitor is an open circuit at d.c. and doesn't influence the circuit much at low frequencies. In effect it is similar to just putting a resistor into a low frequency line. As the frequency increases, the capacitor conducts more and more. This increased conduction tends to short the high frequencies to the signal earth point.

If two of these networks are put in series, a second order filter is produced. The corner frequency is the same, but the roll-off is now twice the above figure, i.e. 12dB/octave. This configuration is shown in Fig. 1b.

Unfortunately, at low frequencies, even though the capacitor has negligible effect on the signal, the resistors do weaken it. To overcome the effect of the resistors, an operational ampli-

COMPONENTS . . .

RESISTORS

R1, R6, R101, R106	27k (4 off)
R2, R5, R8, R11, R102, R105, R108, R111	12k (8 off)
R3, R4, R103, R104	15k (4 off)
R7, R10, R107, R110	18k (4 off)
R9, R12, R109, R112	39k (4 off)
R13, R14	4k7 (2 off)
All ¼W 5%	

CAPACITORS

C1, C6, C101, C106	10µ 16V (4 off)
C2, C3, C102, C103	100n (4 off)
C4, C5, C104, C105	680p (4 off)
C7, C8	220µ 10V (2 off)

SEMICONDUCTORS

IC1, IC2, IC101, IC102	CA3140 (4 off)

MISCELLANEOUS

S1, S3	4-pole, 3-way rotary switch (2 off)
S2, S4	1-pole change-over switch (2 off)
S5	on/off switch

I.c. sockets; I/O sockets; wire; case; battery & clip (PP6); p.c.b.; PE 106, etc.

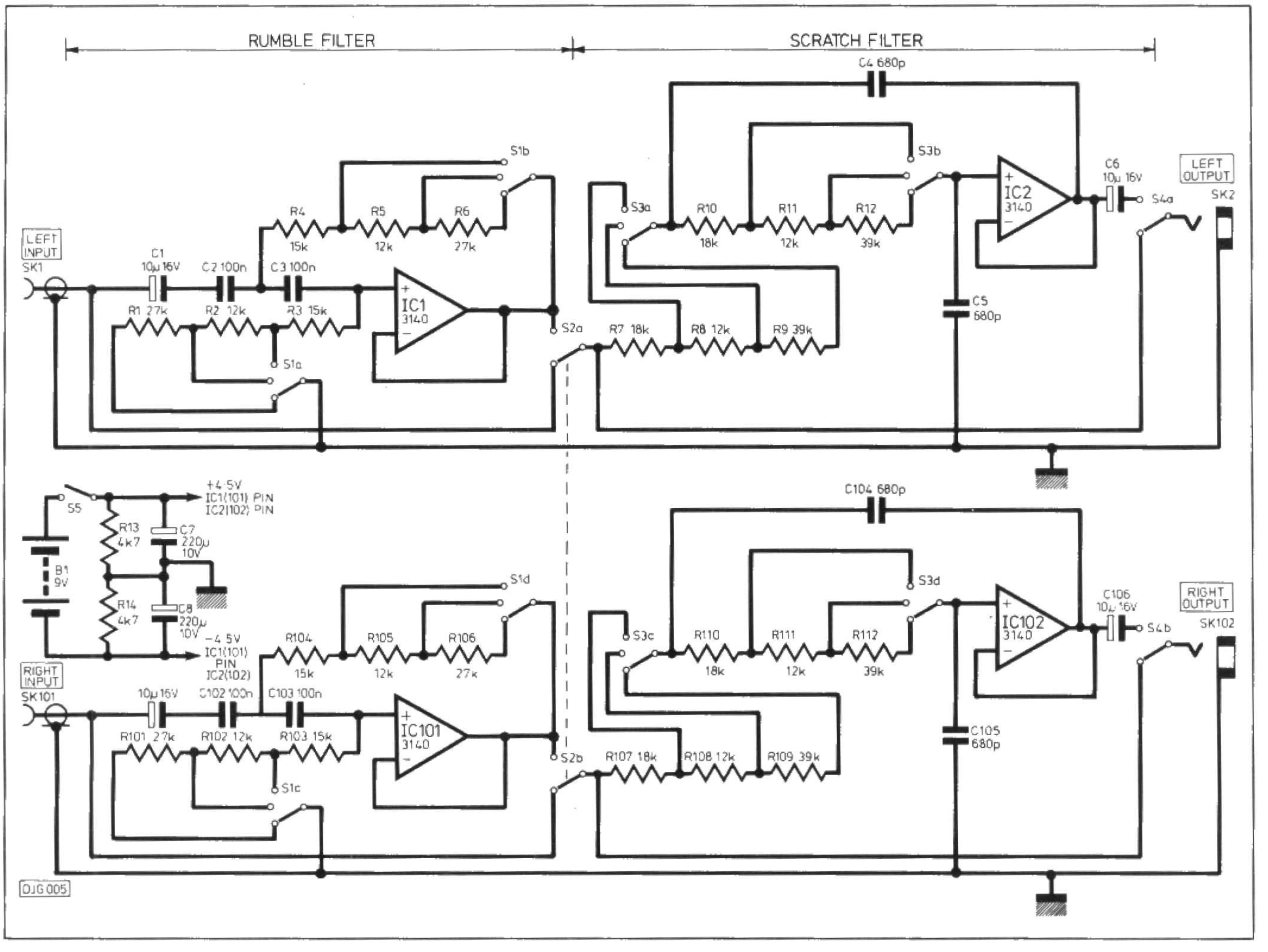


Fig. 3. *Complete circuit diagram*

fier is used to boost the signal back to its original level. A schematic diagram is shown in Fig. 1c. This provides a system which doesn't alter the signal below the cut-off (or corner) frequency, and attenuates the signal at 12dB/octave after it. The gain of the op-amp should be set to just cancel the effect of the resistive signal drop.

A complete circuit diagram of the unit is shown in Fig. 3. To set this gain, external components are needed around the op-amp. These extra components can be removed if the op-amp is set up as a voltage follower and the grounded end of the first filter capacitor connected to the op-amp output instead. This is the standard second order Sallen & Key circuit shown in Fig. 2.

The variable corner frequencies are found by varying the values of the resistors together. This was achieved with 4-pole, 3-way switches. A split rail supply was derived from a 9V battery with R13 and R14. This supply rail (signal earth) was decoupled with C7 and C8.

CONSTRUCTION

Construction of the project is fairly simple if it is done with some degree of care. There is a moderate amount of interwiring to be carried out, this is due to the great versatility of the project.

The p.c.b. should be constructed in the usual method, wire links first followed by resistors, i.c. sockets, Vero pins and capacitors. When wiring the project, it is advisable to use screened leads for the inputs to the board.

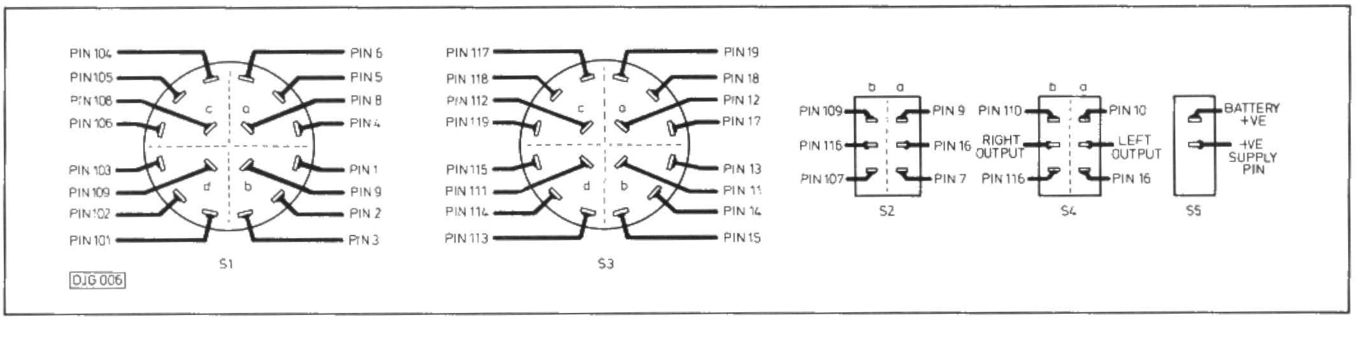


Fig. 4. *Switch wiring details*

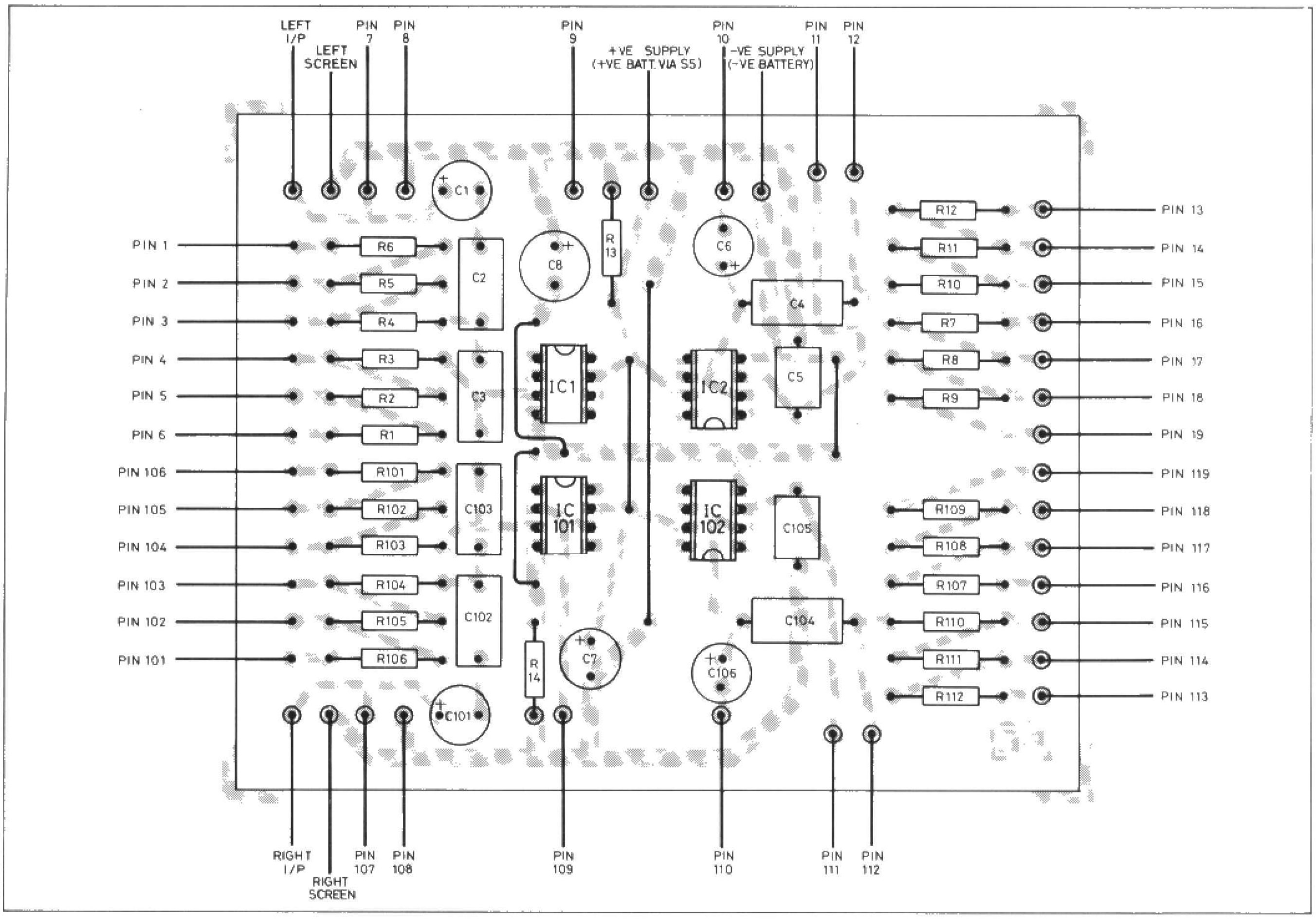


Fig. 5. *P.c.b. design and component layout*

Both left and right channels have been put on the same board for simplicity. The components for the right channel are all numbered upwards from 100. R1 in the left channel is duplicated in the right channel by R101.

The output sockets should be chosen to suit the equipment which the unit is to be used with. The prototype used DIN sockets. The unit can either be fitted into a plastic or a metal case, the prototype being housed in a plastic case.

IN USE

If the circuit is wired correctly, there is no setting up required. As there is a fair amount of wiring, a moderate amount of care should be taken with it. The wiring is not difficult, maybe just a little tedious.

In use, the cut-off frequencies should be set to give the best sound according to your taste. The prototype was used between a pair of tape decks in a Hi-Fi system. The power for the prototype was provided by a PP6 battery. If a mains supply is being considered, care should be taken to ensure that mains hum does not find its way onto the power supply rails due to insufficient power supply decoupling. PE

P.C. BOARDS

Printed circuit boards for certain PE constructional projects are now available from the PE PCB Service, see list. They are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: **PE PCB Service, Practical Electronics, Practical Electronics Magazines Ltd, 16 Garway Road, London, W2.** Cheques should be crossed and made payable to Practical Electronics Magazines Ltd.

Please note that when ordering it is important to give project title, order code and the quantity. Please print name and address in Block Capitals. Do not send any other correspondence with your order.

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: Please allow 28 days for delivery. We can only supply boards listed here.

PROJECT TITLE	ORDER CODE	COST
MAR '84		
Spectrum Autosave	430–01	£2.90
MAY '84		
Sustain Unit	405–02	£2.90
Audio Signal Generator	405–03	£4.28
"	405–04	£2.90
JUNE '84		
Cross Hatch Generator	406–01	£3.52
JULY '84		
Simple Logic Analyser I	407–01	£7.73
EPROM Duplicator	407–02	£3.74
Alarm System	407–03	£3.19
Oscilloscope Calibrator	407–04	£4.23
AUG '84		
Comm. 64 RS232C Interface	408–01	£3.02
Field Measurement	408–02	£3.19
"	408–03	£2.90
Simple Logic Analyser II	408–05	£2.93
SEPT '84		
Parallel to Serial Converter	409–01	£2.92
Through the Mains Controller	409–02	£2.90
"	409–03	£2.90
OCT '84		
Logic Probe	410–01	£2.90
NOV '84		
Computer DFM Adaptor	411–01	£2.90
DEC '84		
Ni-Cad Charger	412–01	£2.90
JAN '85		
Outrider Car Computer (Set of 2)	501–01	£9.10
FEB '85		
Modular Audio Power System		
Pt-1: Power Amp Board	502–01	£4.19
Spectrum DAC/ADC Board	502–02	£3.69
MAR '85		
Modular Audio Power System		
Pt-2: Pre-Amp/Line Driver	503–01	£5.00
Main Board	503–02	£5.12
Heart Beat Monitor—Main Circuit Board	503–03	£8.90
—Detector	503–04	£6.62
Low Cost Speech Synthesiser	503–05	£3.42
APRIL '85		
Power Control Interface	504–01	£3.36
Disc Drive PSU	504–02	£6.54
Modular Audio Power System		
Pt-3: Test Signal Source	504–09	£4.20
Power Supply	504–10	£4.17
MAY '85		
Amstrad Synthesiser Interface	505–01	£4.23
Rugby Clock Pt-2	504–03	£24.22
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"	504–05	£5.12
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CBM64 Music Keyboard		
Keyboard	506–02	£4.55
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JULY '85		
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Envelope Shaper	508–01	£3.73
SEPT '85		
Car Boot Alarm	509–01	£2.90
RS232 To Centronics Converter	509–03	£4.95
OCT '85		
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Modulated Syndrum	005	£3.80
NOV '85		
CBM User Port Expander	006	£3.93
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***Bytebox:** ROM Board (double-sided)	002	£12.75
ZIF Socket	003	£2.90
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Burglar Alarm		
Main Board	020	£4.97
Bell Driver	021	£2.90
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MAR '86		
Clock Timer	027	£6.38
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Transmitter	103	£3.45
Receiver	104	£4.03
Set of two boards	00C	£6.63
IEEE1000 PSU	105	£4.62
Scratch and Rumble Filter	106	£4.51

NEWS LATEST . . .

?MM!

Late News:

This page features a collection of last minute news and press releases received immediately prior to the magazine going to press. Many of the items mentioned on this page will be discussed in greater detail next month.

Multiprocessor systems are made easy with the Hitachi HD63310 smart RAM chip. This chip allows a 1K x 8 memory area to be shared between two microprocessors, each with their own bus access. The chip design incorporates enough inteligence to overcome any potential memory access conflicts.

New super graphics display chips from Texas have just been launched. These chips include the TMS34010, TMS34061 and TMS34070. The TMS34010 graphics system processor is a 32-bit device. The TMS34061 a high resolution video systems controller, and the TMS34070 is a colour palette chip capable of generating up to 4096 colours per frame. This family of chips is capable of generating very high resolution colour graphics displays at great speed.

A new family of very low cost (about £30) mini printers has been launched by Epson. These small dot matrix printers can print up to 42 columns of text or 252 dots per line on 57.5mm plain paper. Their small size, low power consumption and easy interfacing make them ideal for incorporation into portable equipment.

Single chip microcomputers are becoming increasingly versatile and powerful. An example is the new ZTAT range from Hitachi. These devices offer up to 16K bytes of EPROM and 256 bytes of RAM plus a wide range of I/O on a single chip. Probably the most powerfull of the range is the HD63705 with 8K EPROM 348 bytes RAM 68 I/O lines, 5 timers, asynchronous/synchronous serial communications port and an 8-channel 8-bit A/D converter. All EPROMS in this series are easly programmable.

An increased use of Programmable Logic Devices can be expected from the launch by Intel of a new family of Erasable Programmable Logic Devices. These chips use the same technology as EPROMs to allow the designer to rapidly construct custom logic circuits incorporating up to 1200 gates. This makes testing of such devices much easier and far less costly. The 5C060,5C090 and 5C121 offer some exciting opertunities to circuit designers wishing to use PLDs.

Toshiba have anounced the development of an eight colour, active matrix, 640x480 pixels, 10 inch diagonal l.c.d It is backlit and has a brightness nearly equal to that of a colour TV.

The development of Gallium-Arsenide integrated circuits is beginning to gather pace. These very high speed devices are capable of operating at frequencies of up to 1 Gigaherts. Two US companies GigaBit Logic and Vitesse have both announced production of 1000 gate devices and expect to have LSI devices (including microprocessors) in production by late 1987.

EMI MEANS TROUBLE

BY SIMON BATTMAN

The navigation system suddenly flips out of control. Searching frantically for a cause, the pilot pushes every button in sight, but to no avail. Then, almost as quickly as it came, the interference disappears, leaving the crew to wonder what on earth happened.

A potentially disastrous scenario such as this, could in theory be caused by nothing more than a passenger innocently operating a portable computer. Hence, some airlines, notably American, now ban all in-flight computing by their customers.

The culprit is electromagnetic interference (EMI), which is produced whenever electricity flows. You can demonstrate this for yourself by pressing the buttons on a pocket calculator held close to a radio tuned to longwave. If you're lucky you should hear short clicks precipitated by EMI generated by the calculator.

EMI from police radios has been blamed for breath-test machines displaying false readings. TV cameras covering one space shuttle mission apparently caused vital data transmissions to become garbled and, thus lost. Most railway tracks have miles of power cables running parallel to them. EMI produced by these has caused 'stop' signals to be changed to 'go.'

Some experts believe the number of EMI generating machines—satellite ground stations, microwave relays, power lines, computers—and their increasing close proximity to each other is culminating in a 50–60 per cent annual growth of recorded interference.

Computers are not solely responsible, but merely the latest addition to the EMI club. In fact computers can be jinxed by interference as well, leading to temporary malfunctions or even total loss of memory. Home computers have been shown to produce signals as powerful as amateur radio transmitters or CB sets. In America it was recently estimated that some one million homes may be troubled by squawking stereo's and snowy TV pictures, courtesy of EMI.

INDUSTRIAL PROBLEMS

The large increase of computer controlled equipment in industry has provided yet another opportunity for EMI to cause trouble. Industrial robots appear to be particularly prone to interference, not only from other apparatus, but also from fellow robots.

If you own one of the latest high-tech cars, you may experience problems when you're driving in areas populated by large numbers of EMI generating devices. The car's computer receives data from sensors strategically located at points throughout the vehicle. If these signals are disrupted, it could lead to a reduction in engine efficiency and, therefore poor fuel economy.

SHIELDING YOUR SECRETS

Electromagnetic interference is a relatively simple phenomenon to measure, but immensely difficult to cure. At present the only really effective method is for manufacturers or users to shield their equipment. This is expensive and impractical for most situations. For instance, the price of home micros would rocket to a point beyond most people's financial capacity.

In the United States, the Federal Communications Commission (FCC) changed its rules at the end of 1983, calling for more machines to be shielded. This was marvellous news for an increasing number of companies who manufacture specialized shielding materials, but for many others, it became a financial nightmare. Coleco, makers of the Adam personal computer had to delay its introduction, and consequently lost a great deal of money. All thanks to a rather premature decision by the FCC.

For most purposes shielding isn't really needed, particularly when set against the high cost to achieve such protection. However, for some organizations this view may be rather short sighted, if one considers another characteristic of EMI.

Whenever data is displayed on a VDU or sent along cables to printers and other peripherals, the electromagnetic energy radiated will broadcast all this information to the outside world. Anyone with suitable equipment can read a standard unshielded VDU from up to five miles away. What's more, a 'hacker of the airwaves' doesn't need to know the passwords and security codes to gain access.

At one time it was believed, at least in British circles, that few outside governments knew how to accomplish such feats. This fallacy was blown a few months ago, when BBC's Tomorrow's World program demonstrated before viewing millions how easy it is to hack a computer this way. Admittedly their equipment gave a poor image, but nevertheless it was readable and it only cost £100. Given the plans, any competent enthusiast would be able to construct such apparatus with comparative ease.

Government departments have known about EMI hacking for a very long time, consequently all their computers are properly protected. On the other hand, sensitive businesses like banks, have been relatively slow to respond, leading some security consultants to declare they are just ripe for picking. It may be that they have already been picked. PE